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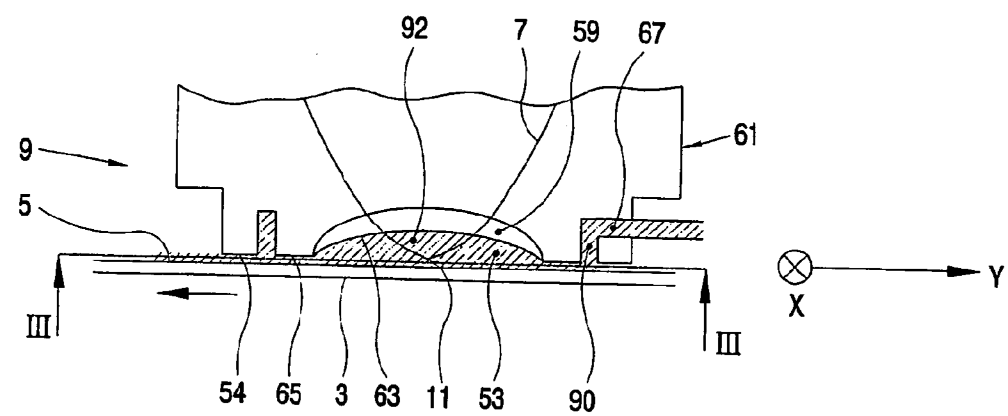
(54) Title: METHOD AND DEVICE FOR IRRADIATING SPOTS ON A LAYER



(57) **Abstract:** For irradiating a layer a radiation beam is directed and focussed to a spot on the layer, relative movement of the layer relative to the optical element is caused so that, successively, different portions of the layer are irradiated and an interspace between a surface of the optical element nearest to the layer is maintained. Furthermore, at least a portion of the interspace through which the radiation irradiates the spot on the layer is maintained filled with a liquid, the liquid being supplied via a supply conduit and flowing out of an outflow opening through a total projected cross-sectional passage area in a plane parallel to the layer. The outflow opening or a plurality of the outflow openings are positioned such that, seen in a direction perpendicular to the layer, the total cross-sectional area has a centre in the portion of the interspace through which the radiation irradiates the spot.

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Method and device for irradiating spots on a layer

The invention relates to a method of irradiating a layer according to the introductory portion of claim 1 and to a device for irradiating a layer according to the introductory portion of claim 7.

Such a method and such a device are known from WO-A-02/13194. According to this publication, the described method and device are used for the manufacturing of an optically scannable information carrier. In such a process, first a master mold is manufactured, and then, by means of the master mold or by means of a daughter mold manufactured by means of the master mold, the information carrier is manufactured by means of a replica process. For manufacturing the master mold, a modulated radiation beam which is directed and focussed to a scanning spot on a photosensitive layer carried by a substrate by means of an optical lens system and the substrate and the lens system are moved relatively to each other. An interspace between the photosensitive layer and a nearest surface of a lens system facing the photosensitive layer is maintained filled up with a liquid.

For moving the substrate relative to the lens system a table carrying the substrate can be rotated about an axis of rotation. By means of a displacement device, the lens system can be displaced with a radial directional component with respect to the axis of rotation of the table. A liquid supply means supplies the liquid into the interspace between the photosensitive layer and a nearest optical surface of the lens system.

A problem of this known method and device is that the immersion of the successive portions of the layer to be irradiated is quite easily disrupted, for instance because the liquid is entrained away from the area of the interspace through which the radiation directed to the radiation spot passes when the layer and the lens move too quickly relative to each other. The immersion can also be disrupted due to important changes in the direction of movement of the lens and the layer relative to each other. The stability of the liquid film between the layer to be irradiated and the nearest optical surface of the optical element can be improved by making the distance between the layer to be irradiated and the nearest optical surface of the optical element very small. However, this entails that the device and in particular the lens nearest to the layer to be irradiated can easily be damaged in the event of contact between the lens and the layer moving relative to each other.

Another method and device for directing a radiation beam to a spot on a photosensitive layer are disclosed in JP-A-10255319. In accordance with this method, a photosensitive layer is applied to a disc-shaped substrate made from glass. The table and the substrate are rotated about an axis of rotation extending perpendicularly to the substrate, and the lens system is displaced, at a comparatively low rate, in a radial direction with respect to the axis of rotation, so that the scanning spot of the radiation beam formed on the photosensitive layer follows a spiral-shaped track on the photosensitive layer. The radiation beam - in this known device a laser beam - is modulated such that a series of irradiated and non-irradiated elements is formed on the spiral-shaped track, which series correspond to a desired series of information elements on the information carrier to be manufactured. The photosensitive layer is subsequently developed, so that the irradiated elements are dissolved and a series of depressions are formed in the photosensitive layer. Next, a comparatively thin aluminum layer is sputtered onto the photosensitive layer, which aluminum layer is subsequently provided with a comparatively thick nickel layer by means of an electro deposition process. The nickel layer thus formed is subsequently removed from the substrate and forms the master mold to be manufactured, which is provided, in the manner described above, with a disc-shaped surface having a series of raised portions corresponding to the desired series of information elements on the information carrier to be manufactured. The master mold thus manufactured can suitably be used in the manufacture of the desired information carriers, however, in general, a number of copies, so-called daughter molds are made by means of the master mold in a replica process. These daughter moulds are used to manufacture the desired information carriers by means of a further replica process, generally an injection molding process. In this manner, the required number of master molds, which are comparatively expensive, is limited. Such a method of manufacturing an optically scannable information carrier, such as a CD or DVD, having pit-shaped information elements by means of a master mold or by means of a daughter mold manufactured by means of the master mold is commonly known and customary.

The interspace between the photosensitive layer and the lens of the lens system facing the photosensitive layer is filled with water. For this purpose, the known device is provided with an outflow opening, which is situated near the axis of rotation of the table. The water supplied via the outflow opening is spread, under the influence of centrifugal forces, substantially throughout the surface of the photosensitive layer, so that also the interspace is filled with water. Since water has a considerably larger optical refractive index than air, the provision of water in the interspace leads to a substantial increase of an angle

which the rays originating from the radiation beam and the optical axis of the lens system include at the location of the scanning spot. As a result, the size of the spot formed by the radiation beam on the photosensitive layer is reduced considerably, so that a much larger number of irradiated and non-irradiated elements can be formed on the photosensitive layer, and the information carrier to be manufactured has a higher information density.

Another example of an application in which the gap between a lens and a surface to be irradiated is maintained filled with a liquid are optical imaging methods and apparatus, such as optical projection lithograpy, in which the spot formed by the radiation projected onto the surface forms an image or a partial image. Such a method and apparatus are described in international patent application WO99/49504.

A drawback of these methods and devices is that the liquid film formed in the interspace is not always reliably maintained fully and in homogenous condition during and after relative displacement of the lens and the surface parallel to the surface. As a result, faults develop in the photosensitive layer. In addition, variations in the condition of the liquid film caused by relative movements of the lens and the surface result in varying forces being exerted on the lens system. Since the lens system is suspended with a limited rigidity, the varying forces exerted by the liquid film cause undesirable vibrations of the lens system, which further disturb the precision with which the image is projected onto the surface. Furthermore, a comparatively large quantity of liquid must be supplied to keep a liquid volume in place in the portion of the interspace through which the radiation passes. As a result, the known device must be provided with extensive measures to prevent undesirable contact between the liquid and other parts of the device.

It is an object of this invention to reliably maintain the portion of the interspace between the optical surface nearest to the layer to be irradiated and that layer through which the radiation passes filled with liquid throughout a larger range of relative velocities and directions of relative displacement of the optical element and the layer.

It is another object of the invention to reduce the risk of damage due to unintentional contact between the optical element and the layer to be irradiated.

According to the invention, these objects are achieved by providing a method according to claim 1. Also according to the invention, a device according to claim 7 is provided for carrying out a method according to claim 1.

The canal distributing supplied liquid longitudinally along the canal and dispensing distributed liquid towards the layer feeds the liquid as a layer. Accordingly, the portion of the interspace fulfilling an optical function can be maintained filled with liquid with less sensitivity to variations in direction and velocity of the movement of the lens or lenses and the layer relative to each other.

That the method and the device are less sensitive to the velocity and direction of displacement of the optical element and the layer relative to each other and variations therein, is not only advantageous in the manufacturing of optical information carriers or molds therefor in which there are at most quite small variations in the direction of movement of the layer relative to the optical element, but also in other applications, such as optical imaging, and more in particular in for instance wafer steppers and wafer scanners for optical projection lithography for example for the production of semiconductor devices in which the direction of movement of the optical element relative to the layer is varied substantially when the wafer is stepped relative to the optical element to bring the optical element into a new position opposite the wafer for projecting the reticle onto a new spot on the wafer or for unrolling (scanning) the projected image of the reticle (mask) over a next area on the wafer. The spot is then formed either by the area of projection of the reticle onto the wafer or by the moving area of projection of a running, usually slit shaped, window portion of the reticle obtained by or as if scanning along the reticle in accordance with movement of the wafer relative to the optical element.

Particular embodiments of the invention are set forth in the dependent claims.

Other objects, features and effects as well as details of this invention appear from the detailed description of a preferred form of the invention.

Fig. 1 is a schematic side view of an example of a device for directing radiation to a spot on a layer;

Fig. 2 is a schematic, cross-sectional view of a distal end portion of a first example of an optical system for a device as shown in Fig. 1, of a layer to which the radiation is directed and of a liquid flow maintained in operation;

Fig. 3 is a schematic, bottom view along the line III-III in Fig. 2

Fig. 4 is a schematic, cross-sectional view of a distal end portion of a third example of an optical system for a device as shown in Fig. 1, of a layer to which the radiation is directed and of a liquid flow maintained in operation;

Fig. 5 is a schematic, bottom view along the line V-V in Fig. 4; and

Fig. 6 is a schematic top plan view representation of a wafer stepper/scanner for optical lithography.

In the manufacture of an optically scannable information carrier, such as a CD or a DVD, a disc-shaped substrate 3 of glass (see Fig. 1) carrying a thin photosensitive layer 5 on one of its two sides is irradiated by means of a modulated radiation beam 7, for instance a DUV laser beam with a wavelength of approximately 260 nm. To irradiate the photosensitive layer 5, use is made of an example 25 of a device in accordance with the invention, which device is described hereinafter with reference to Figs. 1-3. The radiation beam 7 is focused to a scanning spot 11 on the photosensitive layer 5 by an optical system, according to the present example in the form of a lens system 9, including a plurality of optical elements in the form of lenses. The lens system 9 includes an objective lens 55, which is secured in a lens holder 57. The lens system 9 further includes a most distal lens 59, which is the one of the optical elements of the lens system 9 that is located nearest to the layer 5 when in operation. An interspace 53 is maintained between the layer 5 that is irradiated and the one of the optical elements of the lens system 9 that is located nearest to the layer 5. The optical elements may also include other items than lenses, such as filters, shields, diffraction gratings or mirrors.

The layer 5 and the lens system 9 are displaced with respect to each other, so that the modulated radiation beam 7 on the photosensitive layer 5 successively irradiates a series of spaced apart irradiated portions of the layer 5 and does not irradiate portions of the layer 5 in-between the irradiated portions. The irradiated photosensitive layer 5 is subsequently developed by means of a developing liquid, which dissolves the irradiated elements 13 and leaves the non-irradiated elements 15 on the substrate 3. It is also possible to provide that the irradiated portions are left while the non-irradiated portions are dissolved. In both cases, a series of pits or bumps, which corresponds to the desired series of pit-shaped information elements on the information carrier, are formed in the photosensitive layer 5. The photosensitive layer 5 is subsequently covered with a comparatively thin layer of for instance nickel by means of a sputtering process. Subsequently, this thin layer is covered with a comparatively thick nickel layer in an electro deposition process. In the nickel layer, which is eventually removed from the substrate 3, the pattern of pits formed in the photosensitive layer 5 leaves a corresponding pattern that is a negative of the pattern to be formed in the

information carrier to be manufactured, i.e. the master mold comprises a series of raised portions, which correspond to the series of pit-shaped elements formed in the photosensitive layer 5 and to the desired series of pit-shaped information elements on the information carrier. The master mold is thus rendered suitable for use as a mold in an injection-molding machine for injection molding the desired information carriers. Generally, however, a copy of the master mold is used as the mold for injection molding instead of the master mold, which copy of the master mold is commonly referred to as daughter mold, which is manufactured by means of the master mold using a customary replica process which is known per se.

The substrate 3 with the photosensitive layer 5 is placed on a table 27 that is rotatable about an axis of rotation 29, which extends perpendicularly to the table 27 and the substrate 3. The table can be driven by means of a first electromotor 31. The device 25 further comprises a radiation source 33, which, in the example shown, is a laser source, which is secured in a fixed position to a frame 35 of the device 25. It is observed that, as an alternative, the radiation may also be obtained from outside the device. Control over the radiation directed to the layer 5 can be achieved in many ways, for instance by controlling the radiation source 33 and/or by controlling a shutter or radiation diverter (not shown) between the radiation source 33 and the layer 5.

The optical lens system 9 is secured onto a first traveller 37, which can be displaced radially (parallel to the X-direction in the drawings) relative to the axis of rotation 29, by means of a first displacement structure 39. For this purpose, the first displacement structure 39 includes a second electromotor 41 by means of which the first traveller 37 can be displaced over a straight guide 43, which extends parallel to the X-direction and is fixed relative to the frame 35.

A mirror 45 in line with an optical axis 49 of the lens system 9 is also secured to the first traveller 37. In operation, the radiation beam 7 generated by the radiation source 33 follows a radiation beam path 47 extending parallel to the X-direction, and the radiation beam 7 is deflected by the mirror 45 in a direction parallel to the optical axis 49 of the lens system 9. The lens system 9 can be displaced in the direction of its optical axis 49 by means of a focus actuator 51, over comparatively small distances with respect to the first traveller 3, so that the radiation beam 7 can be focused on the photosensitive layer 5. The table 27 with the substrate 5 is rotated about the axis of rotation 29 at a comparatively high speed by means of the first motor 31, and the lens system 9 is displaced parallel to the X-direction by means of the second motor 41 at a comparatively low speed, so that the scanning spot 11 where the

radiation beam 7 hits the layer follows a spiral-shaped track over the photosensitive layer 5, leaving a trail of irradiated and non-irradiated elements extending in accordance with this spiral-shaped track.

The device 25 can suitably be used to manufacture master molds having a comparatively high information density, i.e. by means of the device 25, a comparatively large number of irradiated elements can be provided per unit area of the photosensitive layer 5. The attainable information density increases as the scanning spot 11 is smaller. The size of the scanning spot 11 is determined by the wavelength of the radiation beam 7 and by the numerical aperture of the lens system 9, the numerical aperture depending upon the optical refractive index of the medium present between the lens system 9 and the photosensitive layer 5. The scanning spot 11 is smaller as the refractive index of the medium present between the lens system 9 and the photosensitive layer 5 is larger. Liquids typically have a much larger optical refractive index than air and therefore the portion of the interspace 53 between the lens system 9 and the photosensitive layer 5 through which the beam 7 extends is maintained filled with a liquid - according to this example water. In the present example, water is also particularly suitable because it is transparent to the DUV radiation beam 7 used and it does not attack the photosensitive layer 5.

As shown in Fig. 1, the device 25 according to the present example further includes a liquid removal structure 77, which is provided with a pick-up mouth 79. The pick-up mouth 79 is secured onto a second traveller 81 of the device 25, which can be displaced by means of a second displacement structure 83 of the device 25 in a radial direction with respect to the axis of rotation 29, according to the present example parallel to the X-direction, but another radial direction of displacement may be provided. For driving the displacement of the second traveller 81, the second displacement device 83 comprises a third electromotor 85 connected to the second traveller 81 for displacing the second traveller over a straight guide 87, which is attached to the frame 35 and extends in the directions of displacement of the second traveller 81.

In operation, the pick-up mouth 79 is displaced by means of the third motor 85. The third motor 85 is controlled so that the lens system 9 and the pick-up mouth 79 are continuously situated at substantially equal distances R from the axis of rotation 29 of the substrate 3. In this manner, the pick-up mouth 79 is maintained in a position downstream from the lens system 9 where irradiated portions of the layer 5 pass, so that the liquid supplied at the location of the lens system 9 is entrained by the rotating layer 5 to the pick-up mouth 79 where the liquid is subsequently picked-up from the photosensitive layer 5 by the

pick-up mouth 79. As the water is thus removed from the photosensitive layer 5 downstream from the lens system 9, it is substantially precluded that water that has already been used finds its way back to the interspace 53, thereby disturbing the accurately dosed liquid flow in the interspace 53. In operation, the pick-up mouth 79 is always at a distance R from the axis of rotation 29 which corresponds to the distance R at which the lens system 9 is situated from the axis of rotation 29, both the size and the capacity of the pick-up mouth 79 need only to be comparatively small to remove liquid that has already been used.

Figs. 2 and 3 show, in more detail, the lens system 9, the substrate 3 with the photosensitive layer 5, and the interspace 53 between the photosensitive layer 5 and the lens system 9. The lens 59 nearest to the layer 5 has an optical surface 63 facing the substrate 3 and nearest to the substrate 3. The lenses 55, 59 are suspended in a housing 61, which includes a flat wall 65, which faces the layer 5 and which substantially extends in an imaginary plane perpendicular to the optical axis of the lens 59 nearest to the layer 5. In the surface of the lens system nearest to the layer 5, a recess 92 facing the spot 11 to which the radiation 7 is directed is provided. The surface 63 of the lens 59 nearest to the layer 5 forms an internal surface of the recess 92. This surface 63 also bounds the portion of the interspace 53 through which the radiation 7 irradiates the spot 11. According to the present example, the surface 63 of the lens 59 nearest to the layer 5 is concave so that the deepest point of the recess 92 is in the middle, however, this surface may also be flat or convex.

In operation, the portion of the interspace 53 through which the radiation 7 irradiates the spot 11 on the layer 5 is maintained filled with liquid 91. In the recess 92, the liquid 91 is, at least to some extent, protected against being entrained from the interspace 53. Since, the liquid 91 is less susceptible to being entrained away from the portion of the interspace 53 through which the radiation passes to the spot 11, occurrence of the associated optical distortion caused by the portion of the interspace 53 through which the radiation passes not being completely filled with liquid is thus counteracted.

Moreover, this allows the smallest size of the interspace 53 measured parallel to the optical axis of the lenses 55, 59 to be relatively large. In turn, this reduces the risk of damage to the lens 59 nearest to the layer 5 and the allowable tolerances on the tilt of the lens can be larger without increasing the risk of the lens 59 touching the layer 5.

The recess 92 may for instance be positioned and of such dimensions, so that only a portion of the radiation passes through the recess. However, for a particularly effective protection of liquid 91 across the whole radiation beam, it is preferred that the recess 92 has a rim portion 93 closest to the layer 5, which extends around the radiation 7 irradiating the spot

11. Accordingly, the portion of the interspace 53 in the recess 92 in which liquid 91 is shielded from being entrained extends throughout the whole cross-section of the radiation beam.

The optimum working distance between the layer 5 and the wall 65, i.e. the portion of the lens assembly nearest to the layer 5, is determined by two factors. On the one hand, the distance should be large enough to retain sufficient tolerance on the distance between the substrate 3 and arrangement of the lenses 55, 59 and the housing 61. On the other hand, this distance should not be too large because this would require a too large liquid flow to maintain the immersed condition of the portion of the interspace 53 through which the radiation passes to the spot 11. A presently preferred range for the smallest thickness of the interspace 53 is 3-1500 μm and more preferably 3-500 μm if the liquid is water larger values for the smallest thickness of the interspace can be particularly advantageous if the liquid has a larger viscosity than water. Also the overall width of the outflow opening affects the upper end of the preferred range for the smallest thickness of the interspace, the smallest thickness of the interspace being preferably smaller than $(100 + 1/20 * W)$μm in which W is the overall width of the outflow opening measured in a plane parallel to the layer 5.

The smallest thickness of the interspace may be larger than approximately 10 μm, for instance larger than 15 μm, 30 μm or even 100 μm, to increase the insensitivity to tolerances.

To avoid inclusion of air bubbles in the liquid and for reliably maintaining the filled condition of the portion of the interspace 53 through which the radiation 7 passes to the spot 11, liquid outflow is preferably such that a liquid volume between the wall 65 and the layer 5 is maintained which includes a portion of the interspace 53 upstream (in a direction opposite to the direction of relative movement of the layer 5 in the area of the spot 11) of the portion of the interspace 53 through which the radiation irradiates the spot 11. Thus, a safety margin of liquid upstream is formed which ensures that variations in the distance over which liquid is urged in upstream direction do not cause a disruption of the filled condition of the portion of the interspace 53 through which the radiation 7 passes to the spot 11.

The most downstream outflow opening 90 in the lens system 9 through which the liquid 91 is passed has a total projected cross-sectional passage area in a plane parallel to the layer 5 of which, seen in a direction parallel to the optical axis of the lens system 109, the centre is located inside the portion of the interspace 53 through which the radiation 7 irradiates the spot 11. Accordingly, the average path along which liquid flows out is at least to a large extent centred relative to the portion of the interspace 53 through which radiation

passes to the spot 11. Accordingly, the direction of movement of the layer 5 and the lens arrangement 9 relative to each other in the area of the spot 11 can be varied substantially without disrupting complete immersion of the portion of the interspace 53 through which the spot 11 is irradiated. Even if the direction of movement of the layer 5 is varied substantially, the trace of liquid 95 will still cover the entire portion of the interspace 53 through which the spot is irradiated. Nevertheless, areas of the outflow opening 90 around the beam 7 are located close to the beam, so that superfluous wetting of the layer 5 is limited.

According to the present example, the portion of the interspace 53 through which the radiation 7 irradiates the spot 11 is also centrally located relative to the outflow opening 90 to such an extent that the trace 95 of liquid 91 fed from the outflow opening 90 into the interspace 53 completely immerses the portion of the interspace 53 through which the radiation 7 irradiates the spot 11, not only while, in the position of the spot 11, the layer 5 and the at least one lens system 9 move relative to each other in the direction indicated by the arrow 52 (which indicates the direction of movement of the layer 5 relative to the lens system 9), but also while, in the position of the spot 11, the layer 5 and lens system 9 move relative to each other in opposite direction.

The more the direction of movement of the layer 5 and the lens system 9 parallel to the layer 5 in the area of the spot 11 can be changed without disrupting the immersion of the portion 194 of the area 153 through which the radiation passes, the more the device is suitable for applications in which the spot 11 needs to move over the surface of the layer in widely varying directions, such as in imaging processes in which the spot is a two-dimensional image projected to the layer 5. In such applications, the advantage of a comparatively large refractive index between the lens system and the medium between the lens system and the irradiated surface is that the image can be projected with a higher resolution, which in turn allows further miniaturization and/or an improved reliability.

An example of such applications is optical projection lithography for the processing of wafers for the manufacture of semiconductor devices. An apparatus and a method for this purpose are schematically illustrated in Fig. 6. Wafer steppers and wafer scanners are commercially available. Accordingly, such methods and apparatus are not described in great detail, but primarily to provide an understanding of liquid immersion as proposed in the present application in the context of such optical imaging applications.

The projection lithography apparatus according to Fig. 6 includes a wafer support 12 and a projector 13 having a lens assembly 14 above the wafer support 12. In Fig. 6, the wafer support 12 carries a wafer 15 on which a plurality of areas 16 are intended to be

irradiated by a beam projecting an image or partial image of a mask or reticle 17 in a scanner 18 operatively connected to the projector 13. The support table is moveable in X and Y direction along spindles 19, 20 driven by spindle drives 21, 22. The spindle drives 21, 22 and the scanner 18 are connected to a control unit 23.

Usually one of two principles of operation are applied in optical lithography. In the so-called wafer stepper mode, the projector projects a complete image of the reticle onto one of the areas 16 on the wafer 15. When the required exposure time has been reached, the light beam is switched off or obscured and the wafer 15 is moved by the spindle drives 21, 22 until a next area 16 of the wafer is in the required position in front of the lens assembly 14. Dependent on the relative positions of the exposed area and the next area to be exposed, this may involve relatively quick movement of the lens assembly 14 along the surface of the wafer in widely varying directions. The size of the irradiated spot on the surface of the wafer in which the image of the reticle is projected is typically about 20 x 20 mm, but larger and smaller spots are conceivable.

In particular when it is desired to manufacture larger semiconductor units, it is advantageous to project the image in the other mode, usually referred to as the wafer scanner mode. In that mode, only a slit-shaped portion of the reticle is projected as a slit shaped spot having a length that is several (for instance four or more times) times larger than its width in an area 16 on the surface of the wafer 15. A typical size for the spot is for instance 30 x 5 mm). Then, the reticle 17 to be scanned is moved along the scanning window while the wafer support 12 is synchronously moved relative to the lens assembly 14 under control of the control unit 23 with a velocity adapted so that only the projection spot, but not the scanned partial image portions of the reticle 17 that are projected on the wafer move relative to the wafer 15. Thus, the image of the reticle 17 is transferred to an area 16 of the wafer as successive portions "unroll" as the spot progresses over the wafer. The movement of the wafer 15 relative to the lens assembly 14 while a running window portion of the reticle is projected onto the wafer 15 is usually carried out relatively slowly and usually each time in the same direction. After the complete image of a reticle 17 has been projected onto the wafer 15, the wafer 15 is generally moved much more quickly relative to the lens assembly 14 to bring a next area of the wafer 15 where a next image of the or a reticle 17 is to be projected in front of the lens assembly 14. This movement is carried out in widely varying directions dependent on the relative positions of the exposed area 16 of the wafer 15 and the next area 16 of the wafer 15 to be exposed. To be able to recommence irradiating the surface of the wafer 15 after the displacement of the wafer 15 relative to the lens 14 (i.e. also the lens or the

lens and the wafer may be moved), it is advantageous if the liquid volume in the interspace between the lens 14 and the surface of the wafer 15 through which the radiation passes is immediately filled with liquid after completion of that movement, so that the space is reliably immersed before radiation is recommenced.

Also for optical lithography, water can be used, for instance if the radiation is light of a wavelength of 193 nm. However in some circumstances other liquids may be more suitable.

Returning to Figs. 2 and 3, since the recess 92 is bound by a concave portion of the surface 63 of the lens 59 nearest to the spot 11 on the layer 5 to which the beam of radiation7 is directed, the advantages of having a recess 92 are combined with a relatively uniform flow pattern throughout the portion 94 of the interspace 53 through which radiation 7 passes to the spot 11. In particular, a uniform pattern of flow velocity gradients in the interspace 53 is obtained. In turn, the relatively uniform flow pattern is advantageous to avoid inducing vibrations and for obtaining a continuous uniform supply of fresh liquid and thereby a uniform, steady liquid temperature. These effects are both advantageous for avoiding optical disturbance of the radiation beam 7.

In Fig. 3, the dotted circle designated by reference numeral 94 indicates the perimeter of the portion of the interspace 53 between the lens 59 and the layer 5 through which the radiation beam 7 passes.

For supplying liquid 91 to the interspace 53 between the lens 59 and the layer 5, a liquid supply conduit 67 extends through the housing 61 and leads to an outflow opening 90. According to the present example, the outflow opening 90 has the form of a canal structure in a surface 54, which canal structure 90 is open towards the layer 5, for distributing supplied liquid 91 longitudinally along the canal 90 and dispensing distributed liquid towards the layer 5. In operation, the liquid 91 is distributed by the canal structure 90 longitudinally along that canal structure and the liquid 91 is dispensed from the canal structure 90 towards the layer 5. This results in a relatively wide liquid trace 95 and full immersion of the portion 94 of the interspace 53 through which the radiation beam 7 passes, even if the direction of movement of the lens system 9 and the layer 5 relative to each other parallel to the plane of the layer 5 is changed substantially.

The canal 90 can have various forms. In the embodiment shown in Figs. 2 and 3, the canal is formed such that the outflow opening 90 is located outside the radiation beam7 and extends around the portion 94 of the interspace 53 through which the radiation 7 irradiates the spot 11. The cross 96 indicates the centre, seen in a direction parallel to the

optical axis of the lens system 9, of the total cross-sectional passage area of the outflow opening 90.

The liquid 91 is preferably supplied at a pressure drop over the liquid between the canal structure 90 and the environment that is just sufficient to keep portion of the interspace 53 through which the radiation passes reliably immersed. Thus, the amount of water fed to the surface is kept to a minimum.

Furthermore, when the liquid 91 is dispensed via a canal shaped outflow opening 90, the smallest thickness of the interspace 153 (in this example the distance between the layer 5 and the surface 54 of the wall portion 65) may be larger, without causing an undue risk of disrupting the immersion of the portion 94 of the interspace through which the radiation passes. Therefore, when the liquid is dispensed from a canal-shaped outflow opening 90, the displacement structure 27, 31 and the lens system 9 are preferably positioned and dimensioned for maintaining the smallest thickness of the interspace 53 in a range between 3 and 500 µm.

The flow rate with which the liquid 91 is supplied is preferably such that it can be reliably ensured that a laminar flow with an essentially linear velocity profile and preferably a homogeneous Couette flow is present in the interspace 53. Such a flow exerts a substantially constant force on the wall 65 in which the canal 90 is provided and on the side 63 of the lens 59 nearest to the layer 5. As a result, the liquid present in the interspace 53 exerts substantially no variable liquid forces on the lens system 9. Such varying liquid forces would lead to undesirable vibrations of the lens system 9 and hence to focusing errors and positioning errors of the radiation beam 7 on the photosensitive layer 5. The flow is preferably free of air inclusions, so that the radiation beam 7 is not disturbed.

In Figs. 4 and 5 a second example of a lens system 109 for devices such as the devices shown in Figs. 1 and 6 is shown. According to this example, the outflow opening 190 downstream of the liquid supply canal 167 is also provided with a canal structure open towards the layer 5 (i.e. in the direction in which the beam 107 is directed), but has a different, rectangular shape when seen in axial direction of the lens system 109. An essentially rectangular shape is particularly advantageous for reliably immersing a rectangular area 194 of the interspace intersected by the radiation beam while maintaining a uniform liquid flow patter throughout the intersected portion 194 of the interspace 153, in particular if the movement of the lens system 109 and the layer 5 relative to each other is in a direction perpendicular to one of the sides of the rectangular canal structure 190. Such circumstances typically occur in optical projection lithography.

The recess 192 is bounded by a passage 195 in a wall 165 perpendicular to the axis of the lens system 9 and a surface of the lens 159 nearest to the spot 11 and the surface of the lens 159 nearest to the spot 11 also bounds the portion 194 of the interspace 153 through which the radiation 107 passes to the spot 11. Accordingly, the lens 159 is effectively protected against damage due to inadvertent contact between the lens system 109 and the layer 5 on the substrate 3.

CLAIMS:

1. A method of irradiating a layer including:

directing and focussing a radiation beam to a spot on said layer by means of at least one optical element;

causing relative movement of the layer relative to said at least one optical element so that, successively, different portions of the layer are irradiated and an interspace between a surface of said at least one optical element nearest to said layer is maintained; and

maintaining at least a portion of said interspace through which said radiation irradiates said spot on said layer filled with a liquid, the liquid being supplied via a supply conduit and flowing out of an outflow opening;

characterized in that at least one outflow opening via which the liquid flows out is provided in the form of at least one canal open towards said layer, said canal distributing supplied liquid longitudinally along said canal and dispensing distributed liquid towards said layer.

2. A method according to claim 1, wherein the canal or canals are positioned such that, seen in a direction perpendicular to said layer, the canals define a total cross-sectional area having a centre in said portion of said interspace through which the radiation irradiates the spot.

3. A method according to claim 1 or 2, wherein a smallest thickness of said interspace is maintained at 3-1500 μm.

4. A method according to any one of the preceding claims, wherein at least a portion of said liquid fills up a recess through which said radiation irradiates said spot.

5. A method according to claim 4, wherein the recess has a rim portion closest to said layer extending around said radiation irradiating said spot.

6. A method according to claim 4 or 5, wherein said recess includes a concave portion of said surface of said at least one optical element nearest to said layer.

7. A device for directing radiation to a layer including:

at least one optical element for focussing a beam of radiation originating from said radiation source to a spot on said layer;

a displacement structure for causing relative movement of the layer relative to said at least one optical element so that, successively, different portions of the layer are irradiated and an interspace between said layer and a surface of said at least one optical element nearest to said spot is maintained; and

an outflow opening for supplying liquid to at least a portion of said interspace through which, in operation, said radiation irradiates said spot on said layer, said outflow opening having a total projected cross-sectional passage area in a plane perpendicular to an axis of said radiation beam;

characterized in that the at least one outflow opening is formed by at least one canal open towards said layer, for distributing supplied liquid longitudinally along said canal and dispensing distributed liquid towards said layer.

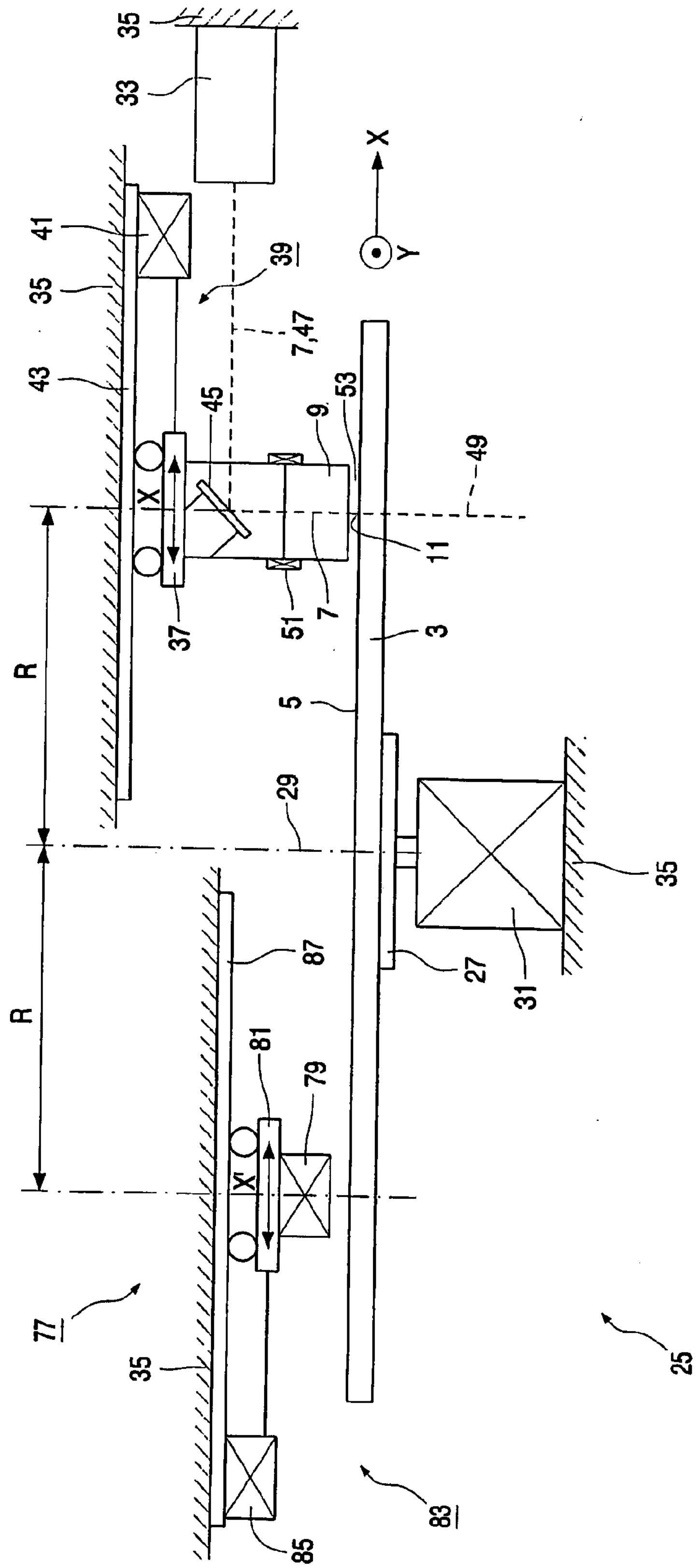
8. A device according to claim 7, wherein the outflow opening or a plurality of the outflow openings are positioned such that, seen in a direction parallel to said axis of said radiation beam, said total cross-sectional area has a centre in said portion of said gap through which the radiation irradiates the spot.

9. A device according to claim 7 or 8, wherein said displacement structure and said recess are positioned and dimensioned for maintaining a smallest thickness of said interspace at 3-1500 μm.

10. A device according to any one of the claims 7-9, wherein a recess is provided in a surface facing said spot, an internal surface of said recess bounding at least said portion of said interspace through which said radiation irradiates said spot.

11. A device according to claim 10, wherein said recess has a rim portion closest to said layer extending around said portion of said interspace through which, in operation, said radiation irradiates said spot.

12. A device according to claims 10 or 11, wherein said recess includes a concave portion of said surface of said at least one optical element nearest to said spot.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83
85

FIG. 1

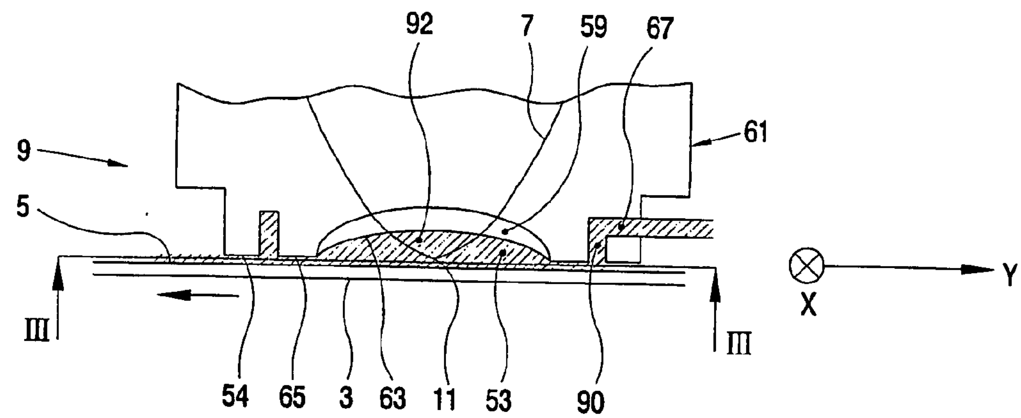
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FIG. 2

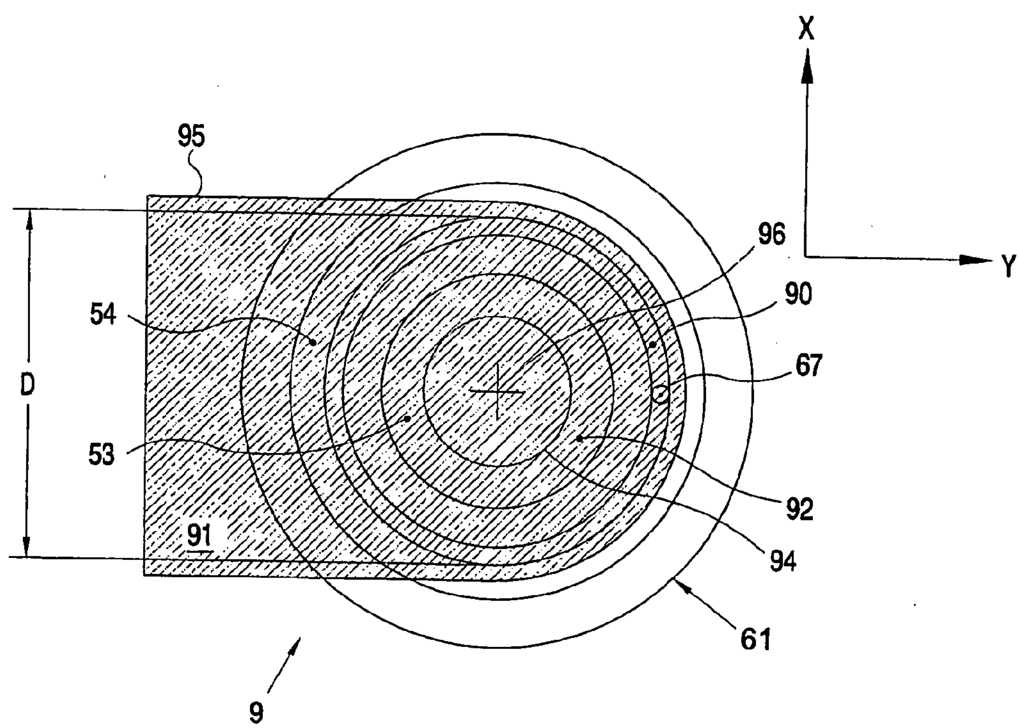
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FIG. 3

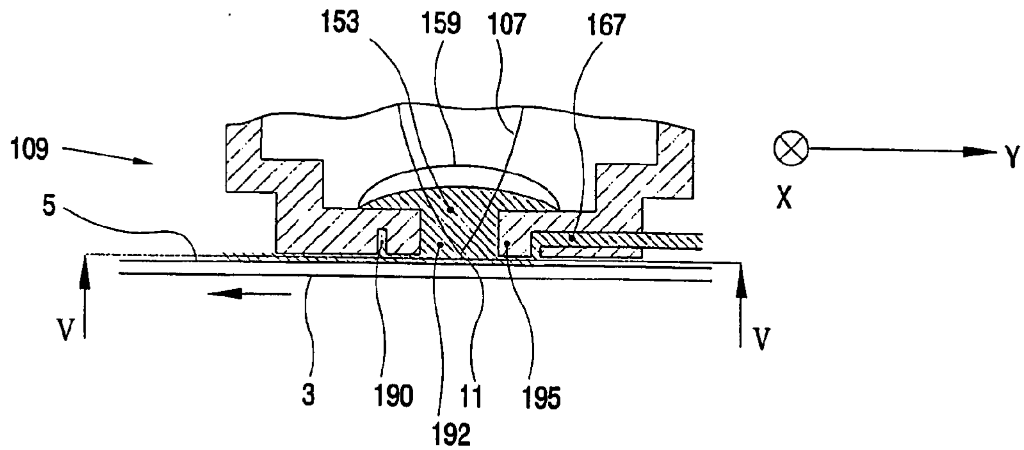

FIG. 4

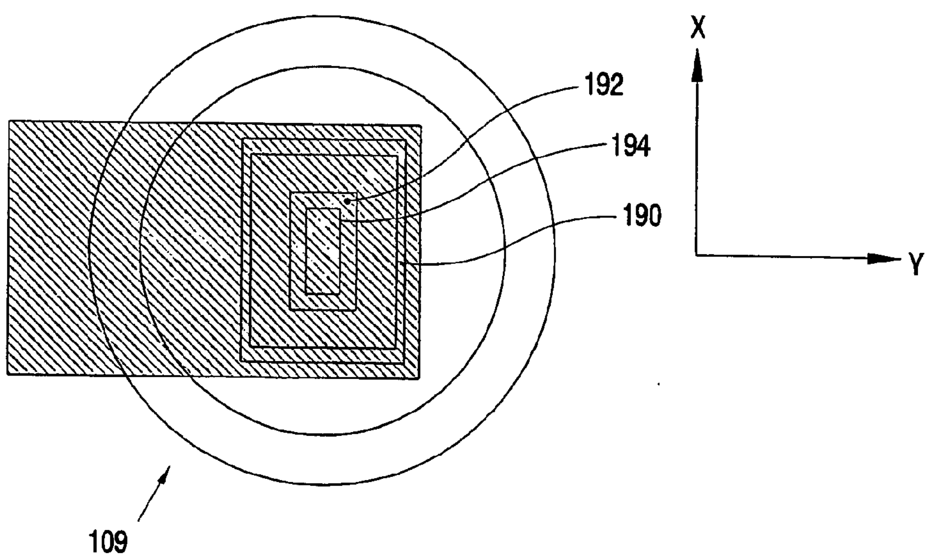

FIG. 5

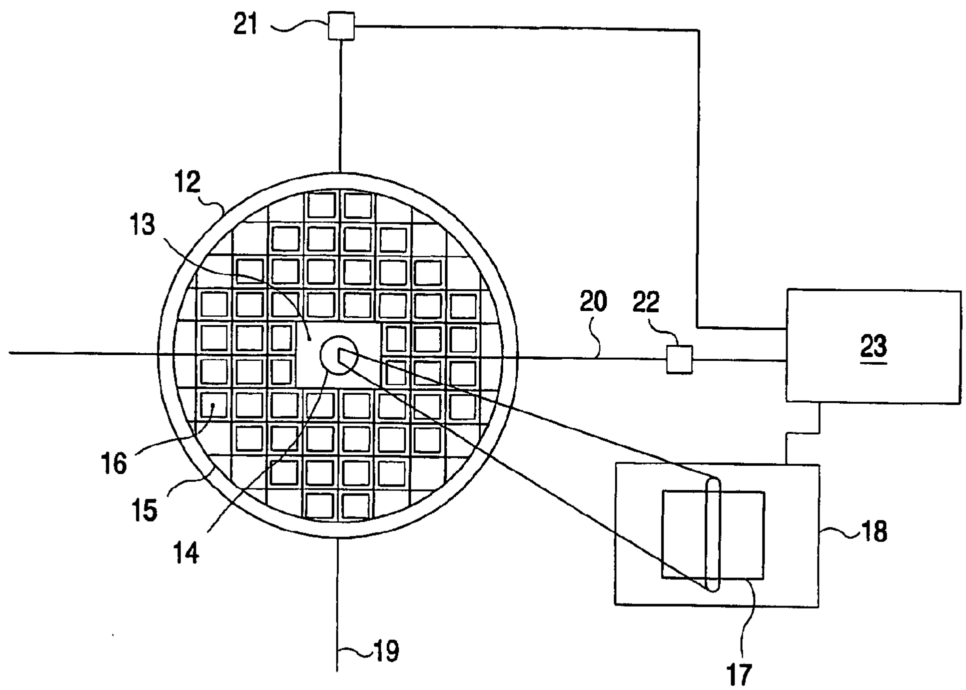

FIG. 6

INTERNATIONAL SEARCH REPORT

Int[illegible]al Application No
PCT/IB 03/05708

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G11B7/135 G11B7/12 G11B7/26 G03F7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G11B G03F G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 02 13194 A (KONINKL PHILIPS ELECTRONICS NV) 14 February 2002 (2002-02-14) cited in the application abstract ---	1-12
A	US 4 480 910 A (TAKANASHI AKIHIRO ET AL) 6 November 1984 (1984-11-06) column 2, line 25 -column 3, line 23; figures 2,3 abstract ---	1-12
A	US 6 236 634 B1 (LEE NEVILLE K S ET AL) 22 May 2001 (2001-05-22) column 7, line 4 -column 7, line 22 column 8, line 62 -column 9, line 55; figures 3-7 abstract -----	1-12

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 April 2004	19/04/2004

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Int[illegible]nal Application No
PCT/IB 03/05708

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WO 0213194	A	14-02-2002	AU	7255901	A	18-02-2002
			BR	0107071	A	25-06-2002
			CN	1386273	T	18-12-2002
			WO	0213194	A1	14-02-2002
			EP	1309971	A1	14-05-2003
			JP	2004506290	T	26-02-2004
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US 6236634	B1	22-05-2001	US	6104687	A	15-08-2000
			WO	9809278	A1	05-03-1998

CLAIMS

[Claim(s)]
[Claim 1]
By at least one optical element, a radiation beam is turned to the spot on a layer, and a focus is doubled,
A relative motion of the layer relevant to said at least one optical element is caused, the part from which said layer differs continuously is irradiated, and the space between the front faces of said at least one optical element nearest to said layer is maintained,
Said a part of space [at least] through which it passes in case said radiation is irradiated by said spot on said layer is filled with a liquid, it is maintained, and said liquid is supplied through a supply pipe and flows out of a tap hole,
The process to carry out is included,
It is characterized by being prepared in the condition that at least one passage is carrying out opening towards said layer, for said passage distributing the liquid supplied to the longitudinal direction along said passage, and at least one tap hole along which it passes in case said liquid flows out turning and distributing the distributed liquid to said layer,
The exposure approach of a layer.
[Claim 2]
It is the approach according to claim 1 characterized by positioning said passage so that all the cross-section fields that have a core may be set to said part of said space which passes along said passage in case said radiation is irradiated by said spot, when it sees in the direction perpendicular to said layer.
[Claim 3]
The smallest thickness of said space is an approach according to claim 1 or 2 characterized by being maintained by three to 1500 micrometer.
[Claim 4]
Claim 1 characterized by filling the recess along which said some of liquids [at least] pass in case said radiation is irradiated by said spot thru/or an approach given in 3 any 1 terms.
[Claim 5]
Said recess is an approach according to claim 4 characterized by having the rim section nearest to said layer prolonged around said radiation which irradiates said spot.
[Claim 6]
Said recess is an approach according to claim 4 or 5 characterized by including the crevice of said front face of said at least one optical element nearest to said layer.
[Claim 7]
At least one optical element which doubles a focus with the spot on a layer for the radiation beam emitted from the radiation source,
Displacement structure which causes a relative motion of said layer relevant to said at least one optical element so that the part from which said layer differs continuously may be irradiated and the space between said layer and the front face of said at least one optical element nearest to said spot may be maintained,
In the tap hole which supplies a liquid to said a part of space [at least] through which it passes

in case said radiation is irradiated by said spot on said layer, said tap hole has all the projected cross-section passage fields in a field perpendicular to the shaft of said radiation beam,
It is characterized by being prepared in the condition that at least one passage is carrying out opening towards said layer, for said passage distributing the liquid supplied to the longitudinal direction along said passage, and said at least one tap hole turning and distributing the distributed liquid to said layer,
Equipment which makes radiation turned to a layer.
[Claim 8]
For all cross-section fields, said one or more tap holes are equipment according to claim 7 characterized by being positioned so that it may have a core into said part of the gap along which it passes in case said radiation is irradiated by said spot, when it sees in the direction parallel to said shaft of said radiation beam.
[Claim 9]
It is equipment according to claim 7 or 8 characterized by positioning said displacement structure and said recess so that the smallest thickness of said space may be maintained by three to 1500 micrometer.
[Claim 10]
A recess is prepared all over the front face which counters said spot,
Even if there is little said space along which it passes in case said radiation irradiates said spot to the inside of said recess, the boundary of said part is restricted,
Equipment according to claim 7 to 9 characterized by things.
[Claim 11]
A recess is equipment according to claim 10 characterized by having the rim section nearest to said layer prolonged around said part of said space along which it passes in case said spot is irradiated.
[Claim 12]
Said recess is equipment according to claim 10 or 11 characterized by including the crevice of said front face of said at least one optical element nearest to said spot.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Field of the Invention]
[0001]
This invention relates to the equipment which irradiates a layer which is in the preface of the approach of irradiating a layer which is in the preface of claim 1, and claim 7.
[Background of the Invention]
[0002]
Such a technique is known in international disclosure official report WO-A-02/13194. According to this periodical, a desired approach and equipment are optically used for manufacture of the information carrier which can be scanned. In such a process, an information carrier is manufactured according to a copy process by the daughter mould which the main mould was manufactured first and manufactured by the main mould or the main mould. In order to manufacture the main mould, the radiation beam and lens system by which it was led to the scan spot on the light-sensitive layer carried by the optical lens system and the substrate, and the focus was united and which were modulated move relatively mutually. The space between the nearest fields of the lens system which counters a light-sensitive layer and a light-sensitive layer is filled with the liquid.
[0003]
In order to move the substrate in response to a lens system, the table which carries a substrate can be rotated centering on a revolving shaft. With displacement equipment, a lens system is taken to the radiation direction component part which rotates centering on the revolving shaft of a table, and it may be replaced with. A liquid supply means supplies a liquid to the space between a light-sensitive layer and the nearest optical surface of a lens system.
[0004]
In order to ride from the space field through which the radiation by which a layer and a lens are led to a radiation spot when a liquid moves the problem of this approach learned and equipment mutual quite promptly passes, dipping of the continuous part of the layer which should be irradiated is made interruption very simply. Dipping may be made interruption by important change of the direction of a motion of a lens and a layer. The stability of the liquid film between the layer which should be irradiated, and the nearest optical surface of an optical element may improve by making very small distance between the layer which should be irradiated, and the nearest optical surface of an optical element. However, it may be simply damaged in this case by contact in the lens and layer by which especially equipment and the lens nearest to the layer which should be irradiated run mutually.
[0005]
The approach and equipment for leading a radiation beam to the spot in a light-sensitive layer are indicated by Japanese patent application disclosure and JP,10-255319,A. By this approach, the light-sensitive layer is applied to the substrate of the disk configuration which consists of glass. A table and a substrate rotate centering on the revolving shaft which has extended at right angles to a substrate, the variation rate of the lens system is comparatively carried out in the radiation direction to a revolving shaft at a low speed, and the scan spot of the radiation beam formed on the light-sensitive layer follows the screw type-like truck of a light-sensitive layer. With a radiation beam and this known equipment, a laser beam is modulated and the irradiated series of the component which is not reached and irradiated is formed on a screw type-like truck. The series concerned corresponds to

the information component series of the request on the information carrier which should be manufactured. A light-sensitive layer improves after that, the irradiated component is decomposed, and depression series is formed into a light-sensitive layer. Next, sputtering of the comparatively thin aluminum layer is carried out on a light-sensitive layer, and the aluminum layer concerned is prepared with a comparatively thin nickel layer according to an electric membrane formation process after that. Thus, as the formed nickel layer was removed from the substrate and formed and mentioned above the main mould which should be manufactured, the main mould is prepared with the disk shaped surface which has the series of the part corresponding to the series of the information component of the request on the information carrier which should be manufactured which went up. Thus, although the manufactured main mould is suitable for being used for manufacture of a desired information carrier, generally many duplicates and the so-called daughter mould are made by the copy process by the main mould. The further copy process and since generally manufactures a desired information carrier according to an injection-molding process, it is used by these daughter moulds. By this approach, the required number of the comparatively expensive main moulds is restricted. Such a manufacture approach of the information carrier which can be scanned on an optical target like CD equipped with the information component of the pit configuration by the daughter mould manufactured by the main mould or the main mould or DVD is learned widely, and is usually-like.

[0006]

The space between the lenses of the lens system which counters a light-sensitive layer and a light-sensitive layer is filled with water. For this reason, the equipment known is formed with the tap hole in which it is located near the revolving shaft of a table. The water supplied through the tap hole is substantially diffused across the front face of a light-sensitive layer under the effect of a centrifugal force, and space is filled with water. Since water has an optical, fairly bigger refractive index than air, supply of the water in space brings about the substantial increment in the include angle in which the light which occurred from the optical axis of the light from a radiation beam and a lens system includes the location in a scan spot. Consequently, the size of the spot formed of the radiation beam on a light-sensitive layer decreases fairly, it reaches, the component for which most number was irradiated and which is not irradiated is formed on a light-sensitive layer, and the information carrier which should be manufactured has higher information density.

[0007]

Other examples from which the gap of a lens and the front face irradiated is continuing being filled with a liquid are the optical image approach like optical projection lithography, and equipment, and the spot formed of the radiation projected on the front face forms an image or a partial image. Such an approach and equipment are indicated by international disclosure official report WO-99/49504.

[Patent reference 1] International disclosure official report WO-A-02/13194 pamphlet

[Patent reference 2] JP,10-255319,A

[Patent reference 3] International disclosure official report WO-99/49504 pamphlet

[Description of the Invention]

[Problem(s) to be Solved by the Invention]

[0008]

The liquid film with which the fault of these approaches and equipment was formed in space is is not of the same quality between the relative variation rates of a lens and a field parallel to a front face, or to the back, and not rationally enough for it necessarily. Consequently, a defect progresses in a light-sensitive layer. In addition, the change in the condition of the liquid film caused by relative motion of a lens and a front face brings about change of the force exerted on a lens system. Since a lens system is hung with the restricted rigidity, change of the force done with a liquid film causes the oscillation which is not desirable as for a lens system, and serves as inhibition of the precision of the image projected on a front face. Furthermore, the liquid of a large quantity must be comparatively supplied so that the liquid volume in the space part which radiation passes may be maintained. Consequently, the equipment known must be formed with the extensive means, in order to prevent the contact which is not [between a liquid and other parts of equipment] desirable.

[0009]

This invention aims at continuing filling rationally the space part of the optical front face nearest to

the layer irradiated, and its layer which radiation passes with a liquid in the rate and direction of the optical element of the big range, and the variation rate of a layer.
[0010]
Another object of this invention is to decrease the danger of breakage by the contact in an optical element and the layer which should be irradiated which is not meant.
[Means for Solving the Problem]
[0011]
According to this invention, these objects are attained by offering the approach of claim 1. Moreover, according to this invention, the equipment of claim 7 is offered in order to perform the approach of claim 1.
[0012]
The liquid route which distributes the supplied liquid to a longitudinal direction along passage, and distributes the distributed liquid toward a layer sends a liquid as a layer. Therefore, the space part which achieves an optical function is the small susceptibility over the change in the direction and rate of a mutual motion of a lens and a layer, and can be filled with a liquid.
[0013]
That the susceptibility over the change in the direction and rate of the relative motion of an optical element and a layer with mutual approach and equipment of this invention is small It is not only advantageous to manufacture of an optical information carrier or a mould with a change very slight in the direction of the motion to the optical element of a layer, but In order to carry an optical element to the new location of a wafer and objection that the image with which reticle [in / for the reticle to the new spot on a wafer / the next field of projection or a wafer] (mask) was projected should be developed (scan), when carrying out the step of the wafer to an optical element In other applications, for example like an optical image like the wafer stepper for the optical projection lithography for manufacture of semiconductor fabrication machines and equipment, and a wafer scanner in the direction of the motion to the layer of an optical element, it changes substantially. scanning a spot along with reticle according to the motion of a wafer to the projection field of the reticle to a wafer, or an optical element -- or the reticle obtained as did so -- it is usually formed of the migration field of projection for a transit window part of a slit configuration.
[0014]
Especially the operation gestalt of this invention is shown by the subordination term.
[0015]
Other objects, descriptions, and effectiveness as well as the detail of this invention are expressed in the detailed explanation in the desirable gestalt of this invention.
[Best Mode of Carrying Out the Invention]
[0016]
The substrate 3 of the shape of a disk of a glass (refer to drawing 1) like CD or DVD which carries [in / optically / manufacture of the information carrier which can be scanned] the light-sensitive layer 5 thin at one of the 2nd page is irradiated by the modulated radiation beam 7, for example, the DUV laser beam whose wavelength is about 260nm. Since the light-sensitive layer 5 is irradiated, Example 25 of the equipment by this invention is used, and the equipment concerned is explained with reference to drawing 1 thru/or 3. The radiation beam 7 can focus on the scan spot 11 on the light-sensitive layer 5 by the optical system expressed with the lens system 9 by this invention including two or more optical elements of a lens format. The lens system 9 contains the objective lens 55 fixed in the lens holder 57. The lens system 9 is one of the optical elements of the lens system 9 which the lens 59 concerned has most near the layer 5 working including the further end lens 59. It is maintained between one of the optical elements of the lens system 9 most near the layer 5 by which space 53 is irradiated, and the layer 5. An optical element may also contain other items other than a lens, for example, a filter, shielding, a concave grating, or a mirror again.
[0017]
The variation rate of a layer 5 and the lens 9 of each other is carried out, and the modulated radiation beam 7 in the light-sensitive layer 5 irradiates the series which is separated from the part by which the layer 5 was irradiated continuously, and does not irradiate the part of the layer 5 between the irradiated parts. The irradiated light-sensitive layer 5 dissolves the irradiated component 13, and is

developed with the developer which leaves the component 15 in a substrate 3 which is not irradiated. It is also possible to leave the irradiated part and to dissolve the part which is not irradiated. In both the case, the series of the pit corresponding to the series of a request of the information component of the pit configuration in an information carrier or a bump is formed into the light-sensitive layer 5. As for the light-sensitive layer 5, nickel etc. is succeedingly covered comparatively with a sputtering process by the film. Then, this film is covered with a comparatively thick nickel layer by the electric membrane formation process. The pattern of the pit formed in the light-sensitive layer 5 leaves the response pattern which is the negative of the pattern formed into the information carrier manufactured, namely, the main mould has the series of the part which went up, and it corresponds in the nickel layer eventually removed from a substrate 3 to the series of the component of the shape of a pit formed into the light-sensitive layer 5, and the series of the information component of the shape of a pit of the request on an information carrier. Thus, the main mould is suitable for the activity as a mould in the injection molding machine for injection molding a desired information carrier. However, generally, the duplicate of the main mould is used instead of the main mould as a mould for injection molding, and the duplicate of the main mould is referred to as a younger sister mould, and is manufactured by the main mould using the usual copy process known in itself.

[0018]

The substrate 3 which has the light-sensitive layer 5 is formed in the pivotable table 27 centering on the revolving shaft 29 vertically prolonged to the table 27 and the substrate 3. A table is operated by the 1st electric motor 31. Equipment 25 has the radiation source 33 further, and by this example, the radiation source 33 is a laser line source, and is being fixed to the fixed position of the frame 35 of equipment 25. Or radiation may be obtained from from outside equipment. Control of the radiation led to a layer 5 can be obtained by [which can obtain by many methods, for example, controls the radiation source 33] depending especially and/or controlling the shutter (not shown) or radiation diverter between the radiation source 33 and a layer 5.

[0019]

It is fixed to the 1st traveller 37 and the optical lens system 9 can displace the 1st traveller 37 centering on a revolving shaft 29 according to the 1st displacement structure 39 at a radial (all over drawing, it is to the direction of X). The 1st displacement structure 39 contains the 2nd electric motor 41 which can be displaced to the straight guide 43 fixed in the direction of X to a frame 35 in the 1st traveller 37 prolonged in parallel for this object.

[0020]

The mirror 45 in the line which has the optical axis 49 of the lens system 9 is also fixed to the 1st traveller 37. In actuation, the radiation beam 7 generated by the radiation source 33 follows the radiation beam way 47 which has extended in parallel in the direction of X, and the radiation beam 7 is deflected for it by the direction parallel to the optical axis 49 of the lens system 9. the lens system 9 -- the focal actuator 51 -- the direction of an optical axis 49 -- per 1st traveller 3 -- a comparison --- like -- short -- a distance variation rate is carried out and the radiation beam 7 can focus on the light-sensitive layer 5. Centering on a revolving shaft 29, the table 27 which has a substrate 5 rotates at high speed comparatively by the 1st motor 31. The lens system 9 A variation rate is comparatively carried out to parallel with the direction of X at low speed by the 2nd motor 41. The spiral truck with which the scan spot 11 which the radiation beam 7 hits in a layer exceeded the light-sensitive layer 5 was followed, and it has left the irradiated trace of the component which is not reached and irradiated which has been prolonged according to this spiral truck.

[0021]

Equipment 25 fits manufacture of the main mould which has comparatively high information density, and the component by which the comparatively large number was irradiated with equipment 25 can be offered for every unit area of the light-sensitive layer 5. The information density which can reach increases as the scan spot 11 becomes small. The magnitude of the scan spot 11 is defined with the wavelength of the radiation beam 7, and the numerical aperture of the lens system 9, and the numerical aperture concerned is based on the optical refractive index of the medium between the lens system 9 and the light-sensitive layer 5. The scan spot 11 is so small that the optical refractive index of the medium between the lens system 9 and the light-sensitive layer 5 is large. Since a liquid has an optical bigger refractive index than air typically, the space part 53 between the lens system 9

and the light-sensitive layer 5 to which the beam 7 has extended is a liquid, and the condition of having been filled with this example with water is maintained. In this example, in order that water may be penetrated with the DUV radiation beam 7 used and may not attack the light-sensitive layer 5, it is especially suitable.

[0022]

As shown in drawing 1 , the equipment 25 of this example includes further the liquid ****** structure 77 established with the pickup opening 79. Although the pickup opening 79 is fixed to the 2nd traveller 81 of equipment 25 and the 2nd traveller 81 is displaced to the direction of X, and parallel by this example in the radiation direction centering on a revolving shaft 29 according to the 2nd displacement structure 83 of equipment 25, another radiation direction of a variation rate may be established. In order to displace to the straight guide 87 which the 2nd traveller 81 was attached in the 2nd displacement equipment 83 by the frame 35 since the variation rate of the 2nd traveller 81 was driven, and has been prolonged in the displacement direction of the 2nd traveller, it has the 3rd electric motor 85 linked to the 2nd traveller 81.

[0023]

In actuation, the variation rate of the pickup opening 79 is carried out by the 3rd motor 85. The 3rd motor 85 is controlled and the lens system 9 and the pickup opening 79 are continuously located in the place of the equal distance R substantially from the revolving shaft 29 of a substrate 3. Thereby, it is maintained in the location which went downward, the liquid supplied in the location of the lens system 9 from the lens system 9 which the part by which the layer 5 was irradiated passes is taken up by the revolution layer 5, a liquid is succeedingly taken up by the pickup opening 79 from the light-sensitive layer 5, and the pickup opening 79 is put. Thus, since water is removed toward the bottom from the lens system 9 from the light-sensitive layer 5, it becomes impossible in operation for the already used water to find the return way to space 53, and 1 time of the exact liquid flow to space 53 is checked. In actuation, the pickup opening 79 is in the place of distance R from a revolving shaft 29 corresponding to the distance R in which the lens system 9 always separated from the revolving shaft 29, and in order that the magnitude and the volume of the pickup opening 79 may remove the already used liquid, only a comparatively small thing is needed.

[0024]

Drawing 2 and drawing 3 show the space 53 between the lens system 9, the substrate 3 which has the light-sensitive layer 5, the light-sensitive layer 5, and the lens system 9 more to a detail. The lens 59 nearest to a layer 5 counters a substrate 3, and has the optical surface 63 nearest to a substrate 3. Lenses 55 and 59 are hung into housing 61, and ** and said housing 61 counter a layer 5, and include the flat wall 65 substantially prolonged in the field on imagination vertical to the optical axis of the lens 59 nearest to a layer 5. In the field of the lens system nearest to a layer 5, the recess 92 which counters the spot 11 to which radiation 7 is led is formed. The field 63 of the lens 59 nearest to a layer 5 forms the inner surface of a recess 92. This field 63 has restricted the boundary of the part of the space 53 through which it passes again since radiation 7 irradiates a spot 11. According to this example, the field 63 of the lens 59 nearest to a layer 5 is a concave surface, and has the vertex of a recess 92 right in the middle. However, this field may be flat or may be a convex.

[0025]

In actuation, the part of the space 53 through which it passes in case radiation 7 irradiates the spot 11 of a layer 5 is filled with the liquid 91. In a recess 92, a liquid 91 is protected from riding from space 53. Since there is almost no susceptibility in a liquid 91 separating and riding from the part of the space 53 through which radiation passes toward a spot 11, radiation passes and generating of distortion of the associated light which is caused by the part of the space 53 which is not filled thoroughly with water is blocked.

[0026]

Furthermore, it permits enlarging comparatively small size of the space 53 which had the dimension taken by the optical axis of lenses 55 and 59 to parallel. Similarly, as for this, the increment in the danger of a lens 59 of contacting a layer 5 can make nothing greatly the permissible strength [in / the danger of damage is decreased and / the inclination of a lens] to the lens 59 nearest to a layer 5.

[0027]

A recess 92 may be positioned, for example and you may make it only a radiation part pass a recess.

However, it is desirable for a recess 92 to have the rim section 93 nearest to a layer 5 prolonged around the radiation 7 which emits a spot 11 for especially effective protection of the liquid 91 which crosses the whole radiation beam. Therefore, the part of the space 53 in the recess 92 protected from a liquid 91 riding is prolonged in all the cross sections of radiation.

[0028]

The optimal practical distance of partial ** of a layer 5 and a wall 65, i.e., the lens assembly nearest to a layer 5, is determined by two elements. One is what the distance concerned should be greatly enough to hold sufficient endurance in the distance between arrangement of a substrate 3, lenses 55 and 59, and housing 61. Another is not too large [this distance]. It is because quite big liquid flow will be required in order to maintain the immersion conditions of the part of the space 53 along which it passes in case radiation passes a spot 11. When a liquid is water, the range where the smallest thickness of space 53 is desirable is three to 1500 micrometer, and is three to 500 micrometer more desirably. When it has viscosity with a bigger liquid than water, a value with the smallest, big thickness of space is effective on actual. Full [of a tap hole] affects the upper bed of the range where the smallest thickness of space is desirable, and, as for the smallest thickness of space, is desirably smaller than mu(100+1/20*W) m, and it is full [of the tap hole where W was measured in the field parallel to a layer 5 in this case].

[0029]

The smallest thickness of space may be larger than about 10 micrometers, for example, may be [that the susceptibility to endurance should be increased] larger than 15 micrometers, 30 micrometers, and 100 micrometers.

[0030]

That the restoration situation of the part of the space 53 along which it passes in case it avoids that air bubbles are contained in a liquid and radiation 7 passes a spot 11 should be maintained rationally Desirably, liquid runoff is maintained so that the part of the upstream space (the direction of a motion of the layer 5 in the field of a spot 11 is the direction of reverse) 53 may be included rather than the part of the space 53 along which the liquid volume between a wall 65 and a layer 5 passes in case radiation is irradiated by the spot 11. Thus, the safe margin of the liquid upstream is formed and change of the distance in which a liquid is hastened in the direction of the upstream does not cause fission of the restoration situation of the part of the space 53 along which it passes in case radiation 7 passes a spot 11.

[0031]

The tap hole 90 of the bottom style in the lens system 9 which a liquid 91 passes has a core inside the part of the space 53 along which it passes in case radiation 7 is irradiated by the spot 11, when it has all the projected cross-section fields in a field parallel to a layer 5 and they are seen in the direction parallel to the optical axis of the lens system 109. Therefore, the average way met in case a liquid flows out is connected with the part of the space 53 along which it passes at least in case radiation 7 is irradiated by the spot 11, and is ******** with a core. Therefore, the direction which the layer 5 and the lens arrangement 9 in the field of a spot 11 move mutually may change substantially, without checking dipping with the perfect part of the space 53 along which it passes in case a spot 11 is irradiated. Even if the direction of a motion of a layer 5 changes substantially, the trace of a liquid 95 will cover a part for all of the space 53 along which it passes in case a spot 11 is irradiated. The field of the surrounding tap hole 90 of a beam 7 is prepared near the beam, and it is restricted that a layer 5 gets wet in an excess.

[0032]

According to this example, the part of the space 53 along which it passes in case a spot 11 is irradiated is located at the core by relation with a tap hole 90, and the trace 95 of the liquid 91 from a tap hole 90 to space 53 immerses the part of the space 53 along which it passes in case a spot 11 is irradiated thoroughly. In the part of a spot 11, a layer 5 and at least one lens system 9 are mutually related in the direction shown by the arrow head 52 (an arrow head 52 shows the direction of a motion of a layer 5 in relation to the lens system 9), and move to it, and in the part of a spot 11, a layer 5 and the lens system 9 are related mutually, and move to an opposite direction.

[0033]

The more the direction of a motion of the lens system 9 parallel to a layer 5 and the layer 5 in the

field of a spot 11 changes a lot, without checking dipping of the part 194 of the space 153 along which it passes in case radiation passes, the more equipment is suitable with the application like the image process by which 2-dimensional image projection of the spot is carried out at a layer 5 with which a spot 11 needs to move the front face of a layer in the direction which changes broadly. In such application, an image is projected by high resolution and that the comparatively big refractive index between the medium between a lens system and an exposure side and a lens system is advantageous brings about the further dependability minimized and/or improved.

[0034]

The example of such application is the optical projection lithography for processing of the wafer kicked to manufacture of a semiconductor device. The equipment and the approach for this object are illustrated by drawing 6 . The wafer stepper and the wafer scanner are commercially possible. Therefore, although such an approach and equipment are not described in a detail, an understanding of dipping proposed with this application in the situation of such optical image equipment is mainly offered.

[0035]

The projection lithography equipment by drawing 6 contains the projector 13 which has the lens assembly 14 after the wafer support 12 and the wafer support 12. In drawing 6 , two or more fields 16 are irradiated to the wafer support 12 by the box by the beam on a wafer 15 in a wafer 15. A beam projects the image or partial image of a mask or reticle in the scanner 18 connected to the projector 13 in actuation. The support table is movable in X and the direction of Y along with the spindles 19 and 20 driven by the spindle drives 21 and 22. The spindle drives 21 and 22 and a scanner 18 are connected to the control unit 23.

[0036]

Usually, one of two principles of operation is applied to optical lithography. In the so-called wafer stepper mode, a projector projects one perfect image of reticle of the field 16 in a wafer 15. When the required exposure time is reached, it is careless, and as for a light beam, the next field 16 of a wafer is moved by the spindle drives 21 and 22, as for a wafer 15 until it is in SUITCHIOFU or the needed location in front of the lens assembly 14. It may be based on the relative location of the exposed field and the next field exposed, and may be accompanied by relative quick motion of the lens assembly 14 which met in the direction which changes broadly on the surface of the wafer. Typically, the size of the exposure spot in the front face of the wafer with which the image of reticle is projected is about 20x20mm, and can consider a small larger or spot.

[0037]

When to manufacture a bigger semi-conductor unit is desired, an image is projected with the mode usually mentioned as wafer scanner mode by the mode of others also advantageously. In this mode, it is projected as a spot of the shape of a slit which has die length with the part of the shape of a slit of reticle larger what time (for example, 4 or more times) than the width of face in the field 16 in the front face of a wafer 15. The typical size of a spot is 30x5 (nm). The reticle 17 scanned is met and moved to a scan aperture, the wafer support 12 moves synchronous in relation to the lens assembly 14 under control of the control unit 23 by the rate which suited, and the projection spot which is not the partial image section by which the reticle 17 projected on a wafer was scanned moves in relation to a wafer 15. Thus, the image of reticle 17 is transmitted to the field 16 of a wafer a continuous part "opens" so that a spot may advance in a wafer. the motion relevant to [while the transit window part of reticle projects a wafer 15 top] the lens assembly 14 of a wafer 15 -- usually -- comparatively -- slowly -- each time -- it performs in the same direction. After the perfect image of reticle 17 is projected on a wafer 15, a wafer 15 is moved general quite promptly by relation with the lens assembly 14 in order to bring about the next field of the wafer 15 with which the next image of reticle 17 is projected in front of the lens assembly 14. This motion changes broadly and the direction which is based on the relative location of the exposed region 16 of a wafer 15 and the next field 16 of the wafer 15 exposed is performed.

If the liquid volume in the space between the lens 14 which radiation passes after completion of a motion, and the front face of a wafer 15 is immediately filled with a liquid to enable it to resume the exposure to the front face of the wafer 15 after displacement of the wafer 15 relevant to a lens 14 (that is, a lens or a lens, and a wafer are moved), the space concerned will be rationally immersed,

before radiation is resumed.

[0038]

In optical lithography, when radiation is the light which is the wavelength of 193nm, water may be used, for example. However, depending on the situation, other liquids may be more suitable.

[0039]

Since the boundary is again restricted by the crevice of the front face 63 of the lens 59 nearest to the spot 11 on the layer 5 which, as for a recess 92, the beam of radiation 7 turns to with reference to drawing 2 and drawing 3 , the advantageous point of having a recess 92 is a thing of the whole part 94 of the space 53 along which it passes in case radiation 7 passes a spot 11 comparatively combined with the flow pattern of homogeneity. Especially, the pattern of the homogeneity of the fluidity inclination in space 53 is obtained. The flow pattern of homogeneity can acquire supply of the continuous homogeneity of **** and a fresh liquid, and the uniform and stabilized liquid temperature for things including change, and is comparatively advantageous. Such effectiveness is advantageous in order to avoid the optical countermeasures of the radiation beam 7.

[0040]

By drawing 3 , the circle of the dotted line shown with a sign 94 shows the circumference of the part of the space 53 between a lens 59 and the layer 5 which the radiation beam 7 passes.

[0041] In order to supply a liquid 91 to the space 53 between a lens 59 and a layer 5, the liquid supply pipe 67 is prolonged through housing 61, and is led to the tap hole 90. According to this example, it has passage structure all over a field 54, and passage structure distributes the liquid supplied to the longitudinal direction along passage, opening of it is carried out toward the layer 5, and it distributes [a tap hole 90 turns the distributed liquid to a layer 5, and] it. In actuation, a liquid 91 is distributed to straight side by passage structure in accordance with passage structure, and a liquid 91 is distributed towards a layer 5 from the passage structure 90. This is ****** also about the result of perfect dipping of the part 94 of the space 53 through which the comparatively large liquid trace 95 and the radiation beam 7 will pass even if the direction of a motion of mutual of the lens system 9 parallel to the field of a layer 5 and a layer 5 changes substantially.

[0042]

Passage 90 may have various configurations. With the operation gestalt shown in drawing 2 and drawing 3 , a tap hole 90 is located in the exterior of the radiation beam 7, and passage 90 is formed, as it has extended around the part 94 of the space 53 along which it passes in case radiation 7 irradiates a spot 11. The cross joint 96 shows the core of all the cross-section passage fields of a tap hole 90 when seeing in the direction parallel to the optical axis of the lens system 9.

[0043]

A liquid 91 is desirable and the parts of the passage structure 90 and the space 53 through which radiation passes are supplied by the pressure from which a liquid falls between sufficient environments to maintain immersing rationally. Thus, the amount of the water given to a field is maintained to the minimum.

[0044]

Furthermore, when a liquid 91 is distributed through the tap hole 90 of a passage configuration, smallest thickness (at this example, it is the distance between a layer 5 and the field 54 of a wall 65) of space 153 may be lengthened, without causing unjust risk of checking dipping of the part 94 of the space through which radiation passes. Therefore, it is positioned in order that the displacement structures 27 and 31 and the lens system 9 may maintain the smallest thickness of space 53 in 3 thru/or the range of 500 micrometers desirably, when a liquid is distributed from the passage configuration tap hole 90, and it is ******** with a dimension.

[0045]

The fluidity to which a liquid 91 is supplied is supplied so that it can guarantee rationally that the sheet metal flow which has an essential straight-line rate profile and a homogeneous Couette flow desirably cuts in space 53. Such a flow uses the substantial fixed force on side 63 of the lens 59 nearest to the wall 65 top with which passage 90 was formed, and a layer 5. Consequently, the liquid in space 53 uses the liquid force in the lens system 9 in which it does not change substantially. Such liquid force of changing causes change of the lens system 9 which is not desirable, and draws the focal error and location error of the radiation beam 7 on the light-sensitive layer 5. A flow is

desirable and the radiation beam 7 is not checked by it excluding air.

[0046]

The 2nd example of the lens system 109 of equipment as shown in drawing 1 and 6 is shown in drawing 4 and 5. According to this example, the tap hole 190 of the lower stream of a river of the liquid supply passage 167 is formed with the passage structure which is carrying out opening towards the layer 5, but it has a rectangle configuration which is different when it sees to the shaft orientations of the lens system 109. Especially when there is a relative motion of the lens system 109 and a layer 5 in the direction vertical to one of the sides of the rectangular passage structure 190, while a rectangular configuration maintains the uniform liquid flow pattern of the partial 194 whole with which space 153 was crossed, it especially takes the rectangle part 194 of the space crossed by the radiation beam to immerse rationally, and is intrinsically advantageous.

[0047]

The recess 192 has restricted the boundary by the front face of the lens 159 nearest to the path 195 and spot 11 in the wall 165 vertical to the shaft of the lens system 9, and has restricted the boundary of the part 194 of the space 153 which passes also along the front face of the lens 159 nearest to a spot 11 in case radiation 107 passes a spot 11. Therefore, a lens 159 is effectively protected from damage by the contact which is not meant between the lens system 109 and the layer 5 on a substrate 3.

[Brief Description of the Drawings]

[0048]

[Drawing 1] It is the outline side elevation of the example of the equipment to which the exposure to the spot on a layer is led.

[Drawing 2] It is the outline sectional view of the end of the 1st example of the optical system of the equipment shown in drawing 1 of the layer of the liquid flow which an exposure is drawn and is maintained working.

[Drawing 3] It is an outline bottom view in alignment with line III-III in drawing 2 .

[Drawing 4] It is the outline sectional view of the end of the 3rd example of the optical system of the equipment shown in drawing 1 of the layer of the liquid flow which an exposure is drawn and is maintained working.

[Drawing 5] It is an outline bottom view in alignment with line V-V in drawing 4 .

[Drawing 6] It is outline top-face drawing of the wafer stepper / scanner for optical lithography.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

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[Drawing 6] It is outline top-face drawing of the wafer stepper / scanner for optical lithography.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]

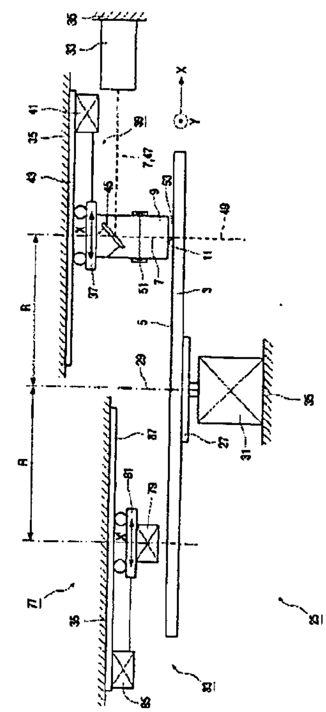

FIG. 1

[Drawing 2]

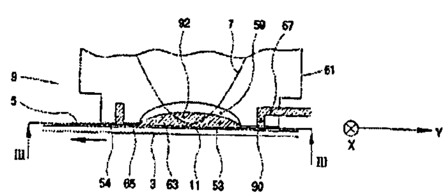

FIG. 2

[Drawing 3]

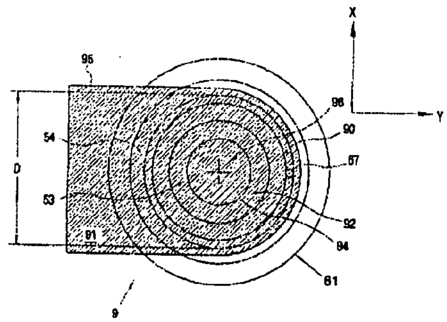

FIG. 3

[Drawing 4]

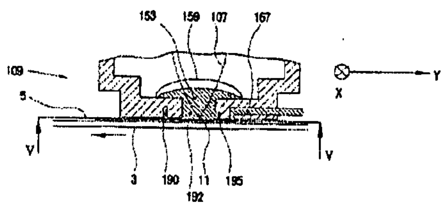

FIG. 4

[Drawing 5]

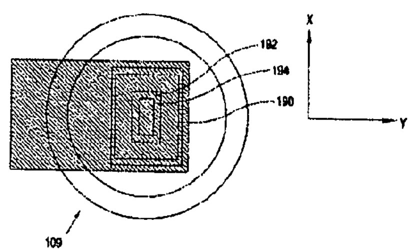

FIG. 5

[Drawing 6]

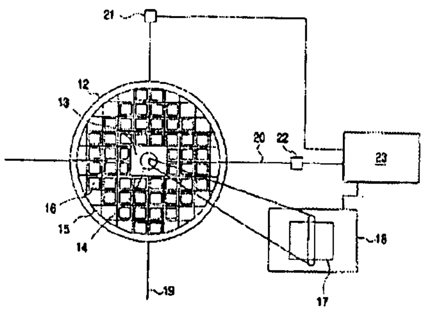

FIG. 6

[Translation done.]

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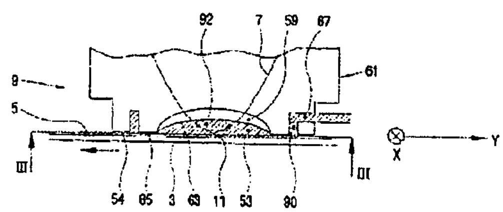
最終頁に続く

(54)【発明の名称】層上にスポットを照射する方法及び装置

(57)【要約】
層を照射するために、放射ビームが層上のスポットに向けて焦点を合わせられ、光学素子と関連する層の相対的動きを引き起こされ、連続的に層の異なる部分が照射され、層に最も近い光学素子の表面の間の空間が維持される。更には、層上のスポットに放射が照射される際に通過する空間の少なくとも一部を液体で満たして維持され、液体は、供給管を介して供給され、液体は層と平行な面における全部の投影された断面通過領域を介して流出口から流出する。１又は複数の流出口は、層と垂直な方向から見たときに、全部の断面領域が、放射がスポットに照射される際に通る空間部分における中心を有するように位置づけられている。



【特許請求の範囲】
【請求項1】
少なくとも1つの光学素子によって放射ビームを層上のスポットに向けて焦点を合わせ、
前記少なくとも1つの光学素子と関連する層の相対的動きを引き起こし、連続的に前記層の異なる部分が照射され、前記層に最も近い前記少なくとも1つの光学素子の表面の間の空間が維持され、
前記層上の前記スポットに前記放射が照射される際に通過する前記空間の少なくとも一部を液体で満たして維持し、前記液体は、供給管を介して供給され流出口から流出し、する工程を含み、
前記液体が流出する際に通る少なくとも一つの流出口が、少なくとも一つの流路が前記層に向けて開口している状態で設けられ、前記流路は、前記流路に沿って長手方向に供給された液体を分配し、分配された液体を前記層に向けて分配することを特徴とする、
層の照射方法。
【請求項2】
前記層と垂直な方向に見たときに、前記流路は、前記放射が前記スポットに照射される際に通る前記空間の前記部分に中心を有する全部の断面領域を定めるように、前記流路は位置づけられることを特徴とする請求項1記載の方法。
【請求項3】
前記空間の最も小さな厚さは、3−1500μmに維持されることを特徴とする請求項1又は2記載の方法。
【請求項4】
前記液体の少なくとも一部が、前記放射が前記スポットに照射される際に通るリセスを満たすことを特徴とする請求項1乃至3いずれか一項記載の方法。
【請求項5】
前記リセスは前記スポットを照射する前記放射の周りに延びている前記層に最も近いリム部を有することを特徴とする請求項4記載の方法。
【請求項6】
前記リセスは、前記層に最も近い前記少なくとも一つの光学素子の前記表面の凹部を含むことを特徴とする請求項4又は5記載の方法。
【請求項7】
放射線源から発せられた放射ビームを、層上のスポットに焦点を合わせる少なくとも1つの光学素子と、
連続的に前記層の異なる部分が照射され、前記層と前記スポットに最も近い前記少なくとも1つの光学素子の表面との間の空間が維持されるよう、前記少なくとも1つの光学素子に関連する前記層の相対的動きを引き起こす変位構造と、
前記層上の前記スポットに前記放射が照射される際に通過する前記空間の少なくとも一部に液体を供給する流出口で、前記流出口は前記放射ビームの軸と垂直な面における全部の投影された断面通過領域を有し、
前記少なくとも一つの流出口が、少なくとも一つの流路が前記層に向けて開口している状態で設けられ、前記流路は、前記流路に沿って長手方向に供給された液体を分配し、分配された液体を前記層に向けて分配することを特徴とする、
層へ放射を向けさせる装置。
【請求項8】
前記1つ又は複数の流出口は、全部の断面領域は、前記放射ビームの前記軸と平行な方向に見たときに、前記放射が前記スポットに照射される際に通るギャップの前記部分に中心を有するように位置づけられていることを特徴とする請求項7記載の装置。
【請求項9】
前記空間の最も小さな厚さは、3−1500μmに維持されるように、前記変位構造及び前記リセスは位置づけられていることを特徴とする請求項7又は8記載の装置。

【請求項10】
リセスが、前記スポットに対向する表面中に設けられ、
前記リセスの内面は、前記放射が前記スポットを照射する際に通る前記空間の少なくとも前記部分の境を限る、
ことを特徴とする請求項７乃至９記載の装置。
【請求項11】
リセスは前記スポットを照射する際に通る前記空間の前記部分の周りに延びている前記層に最も近いリム部を有することを特徴とする請求項１０記載の装置。
【請求項12】
前記リセスは、前記スポットに最も近い前記少なくとも１つの光学素子の前記表面の凹部を含むことを特徴とする請求項１０又は１１記載の装置。
【発明の詳細な説明】
【技術分野】
【0001】
本発明は、請求項１の序文にあるような層に照射する方法及び請求項７の序文にあるような層に照射する装置に関する。
【背景技術】
【0002】
このような技術は、国際公開公報ＷＯ－Ａ－０２／１３１９４において知られている。この刊行物によれば、所望の方法及び装置が、光学的に走査可能な情報キャリアの製造のために用いられる。このようなプロセスでは、先ず主モールドが製造され、主モールド又は主モールドで製造された娘モールドにより、模写プロセスによって情報キャリアが製造される。主モールドを製造するために、光学レンズシステム及び基板によって運ばれた光電性層上の走査スポットに導かれ焦点をあわされた変調された放射ビーム及びレンズシステムは互いに相対的に動く。光電性層と光電性層に対向するレンズシステムの最も近い面との間の空間は、液体で満たされている。
【0003】
レンズシステムに呼応する基板を動かすために、基板を運ぶテーブルは回転軸を中心に回転することができる。変位装置により、レンズシステムは、テーブルの回転軸を中心に回転する放射方向構成部品に取って代えられ得る。液体供給手段は、光電性層とレンズシステムの最も近い光学表面との間の空間に液体を供給する。
【0004】
この知られている方法及び装置の問題は、液体が層及びレンズが互いにかなり迅速に動くときに放射スポットに導かれる放射が通過する空間領域から乗るため、照射されるべき層の連続的部分の液浸は、極めて簡単に不通にされることである。液浸は、レンズ及び層の動きの方向の重要な変化によっても不通にされ得る。照射されるべき層と光学素子の最も近い光学表面との間にある液体フィルムの安定性は、照射されるべき層と光学素子の最も近い光学表面との間の距離を非常に小さくすることによって向上し得る。しかしながら、この場合、装置と特に照射されるべき層に最も近いレンズが、相互に動くレンズと層との接触によって簡単に損傷し得る。
【0005】
光電性層におけるスポットに放射ビームを導くための方法及び装置は、日本特許出願公開・特開平１０－２５５３１９号公報に開示されている。この方法では、光電性層がガラスから成るディスク形状の基板に適用されている。テーブルと基板は、基板と垂直に延出している回転軸を中心に回転し、レンズシステムは、回転軸に対し放射方向に比較的低速で変位され、光電性層上に形成された放射ビームの走査スポットは光電性層の螺旋形状トラックに続く。放射ビーム、この知られた装置ではレーザビームは変調され、照射された及び照射されていない素子のシリーズが螺旋形状トラック上に形成される。当該シリーズは、製造されるべき情報キャリア上の所望の情報素子シリーズに対応する。光電性層はその後向上し、照射された素子が分解され、沈下シリーズは光電性層中に形成される。次に

、比較的薄いアルミニウム層が光電性層上にスパッタリングされ、当該アルミニウム層がその後、電気成膜プロセスにより、比較的薄いニッケル層と共に設けられる。このように形成されたニッケル層は基板から取り除かれ、製造されるべき主モールドを形成し、上述したように、主モールドは、製造されるべき情報キャリア上の所望の情報素子のシリーズに対応する上昇した部分のシリーズを有するディスク形状面と共に設けられる。このように製造された主モールドは所望の情報キャリアの製造に使用されることに適しているが、一般的には、多くの複製、所謂娘モールドが模写プロセスにより主モールドにより作られる。これらの娘モールドは、更なる模写プロセス、一般的には射出成形プロセスにより所望の情報キャリアを製造するために用いられる。この方法で、比較的高価な主モールドの必要な数が制限される。主モールド又は主モールドによって製造された娘モールドによる、ピット形状の情報素子を備えたＣＤ又はＤＶＤのような光学的に走査可能な情報キャリアのこのような製造方法は広く知られており、通例的である。

【0006】

光電性層と光電性層に対向するレンズシステムのレンズとの間の空間は水で満たされている。このため、知られている装置は、テーブルの回転軸の近くに位置する流出口と共に設けられる。流出口を介して供給された水は、遠心力の影響により、実質的に光電性層の表面の至る所に拡散し、空間は水で満たされる。水は空気よりも相当に大きな光屈折率を有するため、空間での水の供給は、放射ビームからの光及びレンズシステムの光軸からの起きた光が走査スポットにおける位置を含む角度の実質的な増加をもたらす。その結果、光電性層上の放射ビームによって形成されたスポットのサイズは相当に減少され、かなりの数の照射された及び照射されていない素子が光電性層上に形成され、製造されるべき情報キャリアはより高い情報密度を有する。

【0007】

レンズと照射される表面とのギャップが液体で満たされ続けている他の例は、光投影リソグラフィのような光画像方法及び装置であり、表面に投影された放射によって形成されたスポットは、画像又は部分的画像を形成する。そのような方法及び装置は、国際公開公報ＷＯ－９９／４９５０４に記載されている。

【特許文献1】国際公開公報ＷＯ－Ａ－０２／１３１９４パンフレット

【特許文献2】特開平１０－２５５３１９号公報

【特許文献3】国際公開公報ＷＯ－９９／４９５０４パンフレット

【発明の開示】

【発明が解決しようとする課題】

【0008】

これらの方法及び装置の欠点は、空間に形成された液体フィルムは必ずしも、レンズと表面に平行な面との相対的な変位の間又は後において等質ではなく、合理的に十分ではないことである。その結果、欠陥は光電性層で発達する。加えて、レンズ及び表面の相対的な動きによって引き起こされる液体フィルムの状態における変化は、レンズシステムに及ぼされる力の変化をもたらす。レンズシステムは、制限された剛性により掛けられるので、液体フィルムによって及ぼされる力の変化は、レンズシステムの望ましくない振動を引き起こし、表面に投影される画像の精度の阻害となる。更には、放射が通過する空間部分における液体容積を維持するように、比較的大量の液体が供給されなければならない。その結果、知られている装置は、液体と装置の他の部分との間の望ましくない接触を防止するために、広範な手段と共に設けられていなければならない。

【0009】

本発明は、照射される層に最も近い光学的表面と放射が通過するその層との空間部分を、大きな範囲の光学素子及び層の変位の速度及び方向において、液体で合理的に満たし続けることを目的とする。

【0010】

本発明の別の目的は、光学素子と照射されるべき層との意図しない接触による損傷の危険性を減少することにある。

【課題を解決するための手段】

【0011】

本発明によれば、これらの目的は、請求項１の方法を提供することによって達成される。また、本発明によれば、請求項７の装置は、請求項１の方法を実行するために提供される。

【0012】

供給された液体を流路に沿って長手方向に分配し、分配された液体を層に向かって分配する液路は、層として液体を送る。したがって、光学機能を果たす空間部分は、レンズと層の互いの動きの方向及び速度における変化に対する小さな感受性で、液体で満たすことができる。

【0013】

本発明の方法及び装置は光学素子と層の互いの相対的な動きの方向及び速度における変化に対する感受性は小さいことは、層の光学素子に対する動きの方向ではごく僅かな変化がある光学情報キャリア又はモールドの製造に有利なだけでなく、ウエハ上の新しいスポットへのレティクルを投影又はウエハの次の領域におけるレティクル（マスク）の投影された画像を展開（走査）すべくウエハと反対の新しい位置に光学素子を運ぶためにウエハを光学素子に対してステップさせるときに、光学素子の層に対する動きの方向における例えば半導体製造装置の製造のための光投影リソグラフィのためのウエハステッパ及びウエハスキャナのような光画像のような他のアプリケーションにおいて実質的に変化する。スポットは、ウエハに対するレティクルの投影領域、又は、光学素子に対するウエハの動きに従ってレティクルに沿ってスキャンすることによって又はそうするようにして得られたレティクルの、通常はスリット形状の走行窓部分の投影の移動領域によって形成される。

【0014】

特に、本発明の実施形態は従属項で示されている。

【0015】

本発明の詳細と同様に、他の目的、特徴及び効果は本発明の望ましい形態における詳細な説明において現される。

【発明を実施するための最良の形態】

【0016】

ＣＤ又はＤＶＤのような光学的に走査可能な情報キャリアの製造においては、２面のうちの１つで薄い光電性層５を運ぶグラス（図１参照）のディスク状の基板３は、変調された放射ビーム７、例えば、波長が約２６０ｎｍのＤＵＶレーザビームによって照射される。光電性層５を照射するために、本発明による装置の例２５が用いられ、当該装置は図１乃至３を参照して説明される。放射ビーム７は、レンズ形式の複数の光学素子を含み、本発明ではレンズシステム９で表される光学システムによる光電性層５上の走査スポット１１に焦点をあてられる。レンズシステム９は、レンズホルダ５７中に固定された対物レンズ５５を含む。レンズシステム９は更に、最も末端なレンズ５９を含み、当該レンズ５９は、動作中に層５の最も近くにあるレンズシステム９の光学素子の１つである。空間５３が照射される層５と、層５の最も近くにあるレンズシステム９の光学素子の１つとの間に維持されている。光学素子はまた、レンズ以外の他のアイテム、例えば、フィルタ、シールド、回折格子、又は鏡等を含んでもよい。

【0017】

層５及びレンズ９は互いに変位され、光電性層５における変調された放射ビーム７は連続して層５の照射された部分から離れたシリーズを照射し、照射された部分間の層５の部分を照射しない。照射された光電性層５は、照射された素子１３を溶解し、基板３における照射されていない素子１５を残す現像液によって現像される。照射された部分を残し、照射されていない部分を溶解することも可能である。両方の場合で、情報キャリアにおけるピット形状の情報素子の所望のシリーズに対応するピット又はバンプのシリーズが光電性層５中に形成される。光電性層５は引き続き、スパッタリングプロセスにより、例えばニッケル等の比較的薄い層によって被覆される。引き続き、この薄い層は、電気成膜プロ

セスにより比較的厚いニッケル層で被覆される。最終的には基板３から取り除かれるニッケル層では、光電性層５に形成されるピットのパターンは、製造される情報キャリア中に形成されるパターンのネガティブである対応パターンを残し、即ち、主モールドは上昇された部分のシリーズを有し、光電性層５中に形成されたピット状の素子のシリーズ及び情報キャリア上の所望のピット状の情報素子のシリーズに対応する。このように主モールドは、所望の情報キャリアを射出成形するための射出成形機におけるモールドとしての使用に適している。しかしながら、一般的には、主モールドの複製は主モールドの代わりに射出成形用のモールドとして使用され、主モールドの複製は妹モールドとして参照され、それ自体知られている通例の模写プロセスを用いて主モールドによって製造される。

【0018】

光電性層５を有する基板３が、テーブル２７及び基板３に対して垂直に延びている回転軸２９を中心に回転可能なテーブル２７において設けられている。テーブルは、第１の電気モータ３１によって運転される。装置２５は更に、放射線源３３を有し、放射線源３３は本例ではレーザ線源であり、装置２５のフレーム３５の固定位置に固定されている。あるいは、放射は装置の外から得られてもよい。層５に導かれる放射の制御は、多くの仕方で得ることができ、例えば、放射線源３３を制御することにより、及び／又は放射線源３３と層５の間の（図示しない）シャッター又は放射ダイバータを制御することにより得ることができる。

【0019】

光学レンズシステム９は第１のトラベラ３７に固定され、第１のトラベラ３７は第１の変位構造３９により回転軸２９を中心に放射状に（図中では、Ｘ方向に平行に）変位できる。この目的のため、第１の変位構造３９は、Ｘ方向に平行に延びている第１のトラベラ３７を、フレーム３５に対し固定されるストレートガイド４３に対し変位可能な第２の電気モータ４１を含む。

【0020】

レンズシステム９の光軸４９を有する線における鏡４５も第１のトラベラ３７に固定している。動作においては、放射線源３３によって発生させられた放射ビーム７はＸ方向に平行に延びている放射ビーム路４７をたどり、放射ビーム７はレンズシステム９の光軸４９と平行な方向に偏向させられる。レンズシステム９は、焦点アクチュエータ５１により、光軸４９の方向に第１のトラベラ３につき比較的短い距離変位され、放射ビーム７は光電性層５に焦点をあてられる。基板５を有するテーブル２７は回転軸２９を中心に、第１のモータ３１により比較的高スピードで回転され、レンズシステム９は、第２のモータ４１により比較的低スピードでＸ方向と平行に変位され、放射ビーム７が層にヒットする走査スポット１１が光電性層５を越えた螺旋状トラックをたどり、この螺旋状トラックに従って延びている照射された及び照射されていない素子の痕跡を残している。

【0021】

装置２５は比較的高い情報密度を有する主モールドの製造に適しており、装置２５により、比較的大きな数の照射された素子を光電性層５のユニットエリアごとに提供し得る。走査スポット１１が小さくなるにつれて、到達可能な情報密度が増加する。走査スポット１１の大きさは、放射ビーム７の波長及びレンズシステム９の開口数によって定められ、当該開口数はレンズシステム９と光電性層５の間の媒体の光屈折率に依拠する。レンズシステム９と光電性層５の間の媒体の光屈折率が大きいほど、走査スポット１１は小さい。液体は典型的には、空気よりも大きな光屈折率を有するため、レンズシステム９とビーム７が延びている光電性層５との間の空間部分５３は液体で、本実施例では水で満たされた状態が維持される。本例では、水は使用されるＤＵＶ放射ビーム７に透過し、光電性層５を攻めないため、特に適している。

【0022】

図１に示されるように、本例の装置２５は更に、ピックアップロ７９と共に設けられる液体取除き構造７７を含む。ピックアップロ７９は、装置２５の第２のトラベラ８１に固定し、第２のトラベラ８１は装置２５の第２の変位構造８３によって回転軸２９を中心に

放射方向に、本例ではX方向と平行に変位するが、変位の別の放射方向が設けられてもよい。第2のトラベラ８１の変位を駆動するために、第2の変位装置８３は、第2のトラベラ８１を、フレーム３５に取り付けられ第2のトラベラの変位方向に延びているストレートガイド８７に変位するために第2のトラベラ８１に接続している第3の電気モータ８５を有する。

【0023】

動作において、ピックアップロ７９は第3のモータ８５によって変位される。第3のモータ８５は制御され、レンズシステム９及びピックアップロ７９は継続的に基板３の回転軸２９から実質的に等しい距離Rのところに位置している。これにより、ピックアップロ７９は、層５の照射された部分が通過するレンズシステム９から下に向かった位置に維持され、レンズシステム９の位置において供給される液体が、回転層５によって、液体が引き続き、ピックアップロ７９によって光電性層５からピックアップされ乗せられる。このように水は光電性層５から、レンズシステム９から下に向かって取り除かれるので、既に使用された水が空間５３への戻り路を見つけることは実施的に不可能となり、空間５３への正確な１回の液体流れが阻害される。動作において、ピックアップロ７９は常にレンズシステム９が回転軸２９から離れた距離Rに対応して回転軸２９から距離Rのところにあり、ピックアップロ７９の大きさ及び体積は、既に使用された液体を取り除くために比較的小さいことだけ必要とされる。

【0024】

図２及び図３は、より詳細に、レンズシステム９、光電性層５を有する基板３、光電性層５とレンズシステム９との間の空間５３を示す。層５に最も近いレンズ５９は、基板３に対向し基板３に最も近い光学表面６３を有する。レンズ５５及び５９はハウジング６１中に掛けれ、前記ハウジング６１は、層５に対向し、層５に最も近いレンズ５９の光軸に垂直な想像上の面に実質的に延びている平坦壁６５を含む。層５に最も近いレンズシステムの面において、放射７が導かれるスポット１１に対向するリセス９２が設けられている。層５に最も近いレンズ５９の面６３は、リセス９２の内面を形成する。この面６３はまた、放射７がスポット１１を照射するために通過する空間５３の部分の境を限っている。本例によれば、層５に最も近いレンズ５９の面６３は凹面であり、リセス９２の最深点は真ん中にある。但し、この面は平坦でも、凸面であってもよい。

【0025】

動作において、放射７が層５のスポット１１を照射する際に通過する空間５３の部分は液体９１で満たされている。リセス９２では、液体９１は空間５３から乗られることから保護される。液体９１は放射がスポット１１に向かって通過する空間５３の部分から離れて乗ることに感受性は殆どないので、放射が通過し水で完全に満たされていない空間５３の部分によって引き起こされる関連付けられた光のゆがみの発生は妨害される。

【0026】

更には、レンズ５５及び５９の光軸に平行に寸法を取られた空間５３の小さなサイズを比較的大きくすることを許容するものである。同様に、これは、層５に最も近いレンズ５９への損害の危険性を減少し、レンズの傾きにおける許容耐久力を層５に接触するレンズ５９の危険性の増加無しに大きくすることができる。

【0027】

リセス９２は例えば、位置付けられてよく、放射部分だけがリセスを通過するようにしてもよい。しかしながら、放射ビーム全体を横切る液体９１の特に効果的な保護のために、リセス９２が、スポット１１を放射する放射７の周りに延びている、層５に最も近いリム部９３を有することが望ましい。従って、液体９１が乗られることから保護されているリセス９２における空間５３の部分が、放射の全断面に延びている。

【0028】

層５と壁６５、即ち、層５に最も近いレンズ組立品の部分、の最適な実用的距離は、２つの要素によって決定される。一つは、当該距離が、基板３とレンズ５５及び５９及びハウジング６１の配置との間の距離における十分な耐久性を保持するに十分に大きくあるべ

きことである。もう一つは、この距離が大きすぎないことである。放射がスポット１１を通過する際に通る空間５３の部分の液浸条件を維持するためにかなり大きな液体流れを要求することになるからである。空間５３の最も小さな厚さの望ましい範囲は、液体が水の場合、３－１５００μｍであり、より望ましくは３－５００μｍである。液体が水よりも大きな粘性を有する場合は、空間の最も小さな厚さの大きな値が実際上効果的である。流出口の全幅もまた、空間の最も小さな厚さの望ましい範囲の上端に影響を与え、空間の最も小さな厚さは望ましくは（１００＋１／２０＊Ｗ）μｍよりも小さく、この場合Ｗは層５と平行な面において計測された流出口の全幅である。

【0029】

空間の最も小さな厚さは、耐久性への感受性を増加すべく、約１０μｍよりも大きくてもよく、例えば、１５μｍ、３０μｍ、１００μｍよりも大きくてもよい。

【0030】

液体に気泡が含まれることを避け、放射７がスポット１１を通過する際に通る空間５３の部分の充填状況を合理的に維持すべく、液体流出は望ましくは壁６５と層５との間の液容積が、放射がスポット１１に照射される際に通る空間５３の部分よりも上流の（スポット１１の領域における層５の動きの方向とは反対の方向の）空間５３の部分を含むように維持される。このように、液体上流の安全なマージンが形成され、液体が上流方向に追い立てられる距離の変化は、放射７がスポット１１を通過する際に通る空間５３の部分の充填状況の分裂を引き起こさない。

【0031】

液体９１が通過するレンズシステム９における最も下流の流出口９０は、層５と平行な面における全部の投影された断面領域を有し、レンズシステム１０９の光軸と平行な方向に見たときに、放射７がスポット１１に照射される際に通る空間５３の部分の内部に中心を有する。従って、液体が流出する際に沿う平均的な路は、少なくとも、放射７がスポット１１に照射される際に通る空間５３の部分と関連して中心付けられる。従って、スポット１１の領域における層５とレンズ配置９が互いに動く方向は、スポット１１が照射される際に通る空間５３の部分の完全な液浸が阻害されずに、実質的に変化し得る。たとえ、層５の動きの方向が実質的に変化したとしても、液体９５の痕跡は、スポット１１が照射される際に通る空間５３の全部分をカバーする。ビーム７の周りの流出口９０の領域はビームの近くに設けられ、層５が余分に濡れてしまうことが制限される。

【0032】

本例によれば、スポット１１が照射される際に通る空間５３の部分は流出口９０との関係で中心に位置しており、流出口９０から空間５３への液体９１の痕跡９５は完全にスポット１１が照射される際に通る空間５３の部分を液浸する。スポット１１の部分において層５及び少なくとも１つのレンズシステム９は矢印５２（矢印５２は、レンズシステム９に関連して層５の動きの方向を示す）によって示された方向に互いに関連して動き、スポット１１の部分において層５及びレンズシステム９は互いに関連して反対方向に動く。

【0033】

放射が通過する際に通る空間１５３の部分１９４の液浸が阻害されずに、層５及びスポット１１の領域における層５と平行なレンズシステム９の動きの方向が大きく変化すればするほど、装置は、スポットが層５に二次元画像投影される画像プロセスの如き、幅広く変化する方向に層の表面をスポット１１が動く必要があるアプリケーションにより適している。そのようなアプリケーションでは、レンズシステムと照射面との間の媒体とレンズシステムとの間の比較的大きな屈折率の有利なことは、画像が高解像度により投影され、更なる最小化及び／又は改良された信頼性をもたらす。

【0034】

このようなアプリケーションの例は、半導体装置の製造にけるウエハの処理のための光投影リソグラフィである。この目的のための装置及び方法は図６に図示されている。ウエハステッパ及びウエハスキャナは商業的に可能である。従って、このような方法及び装置は詳細には記されないが、そのような光画像装置の状況において本出願で提案された液浸

の理解が主として提供される。

【0035】

図６による投影リソグラフィ装置は、ウエハサポート１２及びウエハサポート１２の上にレンズ組立品１４を有する投影機１３を含む。図６において、ウエハサポート１２は、ウエハ１５を箱に、ウエハ１５の上において複数の領域１６がビームによって照射される。ビームは、投影機１３に動作的に接続されたスキャナ１８においてマスク又はレティクルの画像又は部分画像を投影する。サポートテーブルは、スピンドルドライブ２１及び２２によって駆動されるスピンドル１９及び２０に沿ってＸ及びＹ方向に移動可能である。スピンドルドライブ２１及び２２及びスキャナ１８は制御ユニット２３に接続されている。

【0036】

通常は、動作の２つの原理のうちの１つが光リソグラフィに適用される。所謂ウエハステッパモードでは、投影機は、ウエハ１５における領域１６の１つにレティクルの完全な画像を投影する。必要な露出時間に達したときに、光ビームはスィッチオフ又はぼんやりとされ、ウエハ１５はスピンドルドライブ２１及び２２により、ウエハの次の領域１６がレンズ組立品１４の前の必要とされた位置に居るまで動かされる。露出された領域及び露出される次の領域の相対的な位置に依拠して、幅広く変化する方向にウエハの表面に沿ったレンズ組立品１４の相対的な迅速な動きを伴ってもよい。レティクルの画像が投影されるウエハの表面における照射スポットのサイズは、典型的には約２０×２０ｍｍであり、より大きい又は小さいスポットが考えられる。

【0037】

より大きな半導体ユニットを製造することが望まれている場合、有利にも他のモードにより、通常はウエハスキャナモードとして言及されるモードにより、画像を投影する。このモードでは、レティクルのスリット状の部分が、ウエハ１５の表面における領域１６における幅よりも幾倍（例えば、４倍以上）大きい長さを有するスリット状のスポットとして投影される。スポットの典型的サイズは例えば３０×５（ｎｍ）である。走査されるレティクル１７は、走査窓にそって移動し、ウエハサポート１２はレンズ組立品１４と関連して、適合された速度による制御ユニット２３の制御の下、同期的に動き、ウエハに投影されるレティクル１７の走査された部分的画像部ではない投影スポットがウエハ１５と関連して動く。このように、レティクル１７の画像はスポットがウエハにおいて進行するように、連続的な部分が「開く」ように、ウエハの領域１６に伝達される。レティクルの走行窓部がウエハ１５上を投影する間に、ウエハ１５のレンズ組立品１４に関連した動きは、通常は比較的ゆっくりと、各回同じ方向へと実行される。レティクル１７の完全な画像がウエハ１５に投影された後に、レンズ組立品１４の前でレティクル１７の次の画像が投影されるウエハ１５の次の領域をもたらすべく、ウエハ１５はレンズ組立品１４との関係で一般的にはかなり迅速に移動される。この動きは、ウエハ１５の露出領域１６の相対的位置及び露出されるウエハ１５の次の領域１６に依拠する方向を幅広く変化して実行される。

レンズ１４に関連するウエハ１５の変位後ウエハ１５の表面への照射を再開できるようにすべく（即ち、レンズ又はレンズとウエハが動かされる）、動きの完了後に放射が通過するレンズ１４とウエハ１５の表面との間の空間中の液容積が直ぐに液体で満たされると、当該空間は放射が再開される前に合理的に液浸される。

【0038】

光リソグラフィでは、例えば、放射が波長１９３ｎｍの光の場合に、水を用いてもよい。しかしながら、状況によっては他の液体の方がより適している場合もある。

【0039】

図２及び図３を再度参照するに、リセス９２は、放射７のビームが向かれる層５上のスポット１１に最も近いレンズ５９の表面６３の凹部によって境を限られているので、リセス９２を有することの有利な点は、放射７がスポット１１を通過する際に通る空間５３の部分９４の全体の比較的均一のフローパターンと結合されることである。特に、空間５３

における流動度勾配の均一のパターンが得られる。比較的均一のフローパターンは、変化を含みことを避き、新鮮な液体の継続的な均一の供給及び均一で安定した液体温度を得られ、有利である。これらの効果は放射ビーム７の光学的妨害を避けるために有利である。

【0040】

図３では、符号９４で示される点線の円は、レンズ５９と放射ビーム７が通過する層５の間の空間５３の部分の周辺を示している。

【0041】

液体９１をレンズ５９と層５との間の空間５３に供給するために、液体供給管６７はハウジング６１を通じて延びており、流出口９０に導かれている。本例によれば、流出口９０は面５４中に流路構造を有し、流路構造は層５に向かって開口しており、流路に沿って長手方向に供給された液体を分配し、分配された液体を層５に向けて分配する。動作においては、液体９１は流路構造に沿って長手に流路構造によって分配され、液体９１は、流路構造９０から層５に向けて分配される。これは、たとえ層５の面と平行なレンズシステム９及び層５の相互の動きの方向が実質的に変化しても、比較的広い液体痕跡９５及び放射ビーム７が通過する空間５３の部分９４の完全な液浸という結果をもたらず。

【0042】

流路９０は、様々な形状を有し得る。図２及び図３に示した実施形態では、流路９０は流出口９０が放射ビーム７の外部に位置し、放射７がスポット１１を照射する際に通る空間５３の部分９４の周りで延びているように形成されている。十字９６は、レンズシステム９の光軸と平行な方向に見たときの、流出口９０の全部の断面通過領域の中心を示している。

【0043】

液体９１は望ましくは、流路構造９０と、放射が通過する空間５３の部分が合理的に液浸されることを維持するに十分な環境との間で、液体が落ちる圧力で供給される。このように面に与えられる水の量は最小限に維持されている。

【0044】

更には、液体９１が流路形状の流出口９０を介して分配される場合に、空間１５３の最も小さい厚さ（この例では、層５と壁部６５の面５４との間の距離）は、放射が通過する空間の部分９４の液浸を阻害する不当な危険をひきおこさずに、長くしてもよい。従って、液体が流路形状流出口９０から分配される場合に、変位構造２７及び３１及びレンズシステム９は望ましくは空間５３の最も小さな厚さを３乃至５００μｍの範囲に維持するために位置づけられ、寸法付けられる。

【0045】

液体９１が供給される流動度は、望ましくは、本質的な直線速度プロファイル及び均質なクエットの流れを有する薄板流れが空間５３内でおきることを合理的に保証できるように供給される。このようなフローは、流路９０が設けられた壁６５上および層５に最も近いレンズ５９の側６３上の実質的な一定力を働かせる。その結果、空間５３における液体は、レンズシステム９における実質的に変化しない液体力を働かせる。このような変化する液体力は、レンズシステム９の望ましくない変化を引き起こし、光電性層５上の放射ビーム７の焦点エラー及び位置エラーを導く。フローは望ましくは、空気を含まず、それによって放射ビーム７は阻害されない。

【0046】

図４及び５には、図１及び６に示されたような装置のレンズシステム１０９の第２の例が示されている。この例によれば、液体供給流路１６７の下流の流出口１９０が層５に向けて開口している流路構造と共に設けられているが、レンズシステム１０９の軸方向に見たときに異なる矩形形状を有する。本質的に矩形の形状は、特に、レンズシステム１０９及び層５の相対的な動きが、矩形の流路構造１９０の側の１つと垂直な方向にある場合は、空間１５３の横切られた部分１９４全体の均一な液体フローパターンを維持する一方で、放射ビームによって横切られた空間の矩形部分１９４を合理的に液浸するにとって特に有利である。

【0047】

リセス１９２は、レンズシステム９の軸と垂直な壁部１６５内の通路１９５及びスポット１１に最も近いレンズ１５９の表面によって境を限っており、スポット１１に最も近いレンズ１５９の表面もまた、放射１０７がスポット１１を通過する際に通る空間１５３の部分１９４の境を限っている。従って、レンズ１５９は、レンズシステム１０９と基板３上の層５との間の意図しない接触による損害から効果的に保護される。

【図面の簡単な説明】

【0048】

【図1】層上のスポットへの照射を導く装置の例の概略側面図である。

【図2】照射が導かれ、動作中に維持される液体フローの層の、図１に示された装置の光学システムの第１の例の末端部の概略断面図である。

【図3】図２における線III－IIIに沿った概略底面図である。

【図4】照射が導かれ、動作中に維持される液体フローの層の、図１に示された装置の光学システムの第３の例の末端部の概略断面図である。

【図5】図４における線V－Vに沿った概略底面図である。

【図6】光学リソグラフィのためのウエハステッパ／スキャナの概略頂面図である。

【図1】

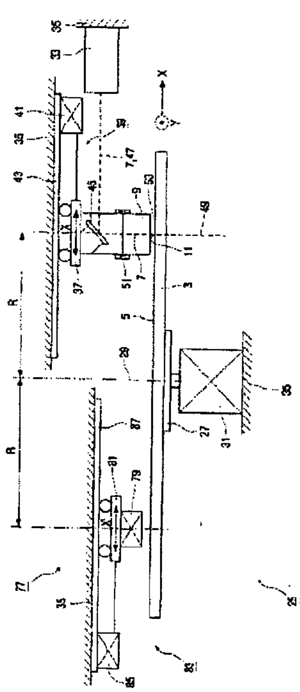


FIG. 1

【図2】

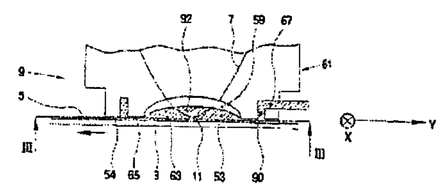


FIG. 2

【図3】

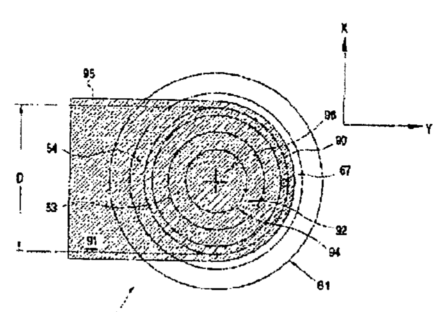


FIG. 3

【図4】

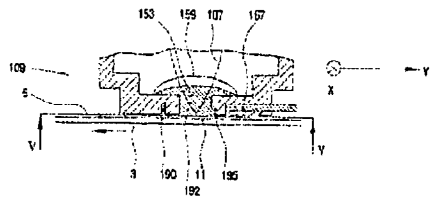


FIG. 4

【図5】

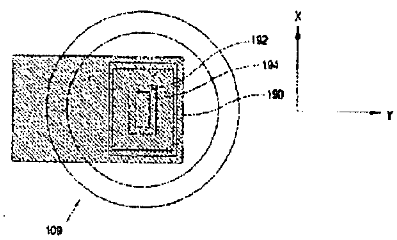


FIG. 5

【図6】

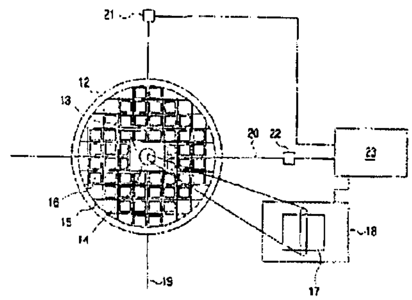


FIG. 6

【国際調査報告】

INTERNATIONAL SEARCH REPORT

Int ... ial Application No
PCT/IB 03/05708

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G11B7/135 G11B7/12 G11B7/26 G03F7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G11B G03F G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 4 480 910 A (TAKANASHI AKIHIRO ET AL) 6 November 1984 (1984-11-06) column 2, line 25 -column 3, line 23; figures 2,3 abstract	1-12
A	US 6 236 634 B1 (LEE NEVILLE K S ET AL) 22 May 2001 (2001-05-22) column 7, line 4 -column 7, line 22 column 8, line 62 -column 9, line 55; figures 3-7 abstract	1-12

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 April 2004	19/04/2004

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

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